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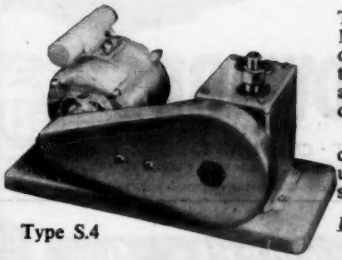

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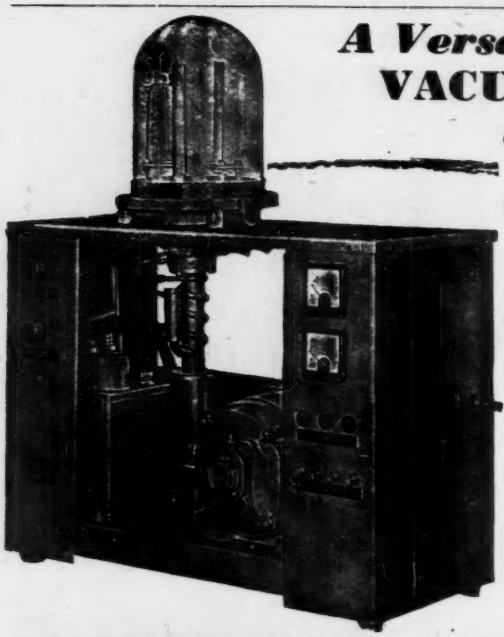

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NATIONAL PARKS IN GREAT BRITAIN

THE fifth report of the National Parks Commission* appears at a moment when at least two matters of current controversy give particular point to the retrospect and prospect with which the Commission concludes the normal review of a year's activities. Taken by themselves, the year's activities of the Commission constitute a record of creditable achievement. No new 'parks' were designated in Great Britain during the year, though progress is apparent with the designation of the Yorkshire Dales National Park, and the negotiations for a Cheviot National Park are particularly encouraging, both because a proposal was put forward on the initiative of the Northumberland County Council for a Northumberland National Park embracing also the Kielder moors and part of the Roman Wall area, and for the evidence it affords of a clearer and wider understanding of the purpose of a 'national park'. Preliminary discussions have also been held regarding the Brecon Beacons and the Black Mountains area; on the other hand, except in the Peak District National Park, the administrative arrangements still leave much to be desired and there is little evidence here of progress towards fulfilling the purpose of the Act. The Pembrokeshire Coast National Park Committee has taken the welcome step of setting up an architectural panel to advise on certain planning applications before submission to the Committee, and the Commission professes satisfaction with the work carried out by the Peak District and Lake District National Park Planning Boards. For example, the former Board has completed its survey of 'open country' and has made substantial progress in negotiations with landowners for the conclusion of public access agreements in the Kinder Scout area. The Lake District Board has organized the permanent camping site at Silecroft and made substantial progress with the development of organized caravan sites by private enterprise.

Much of the work of whatever administrative authority is established for a national park will consist of the quiet implementation of specific proposals and of educating public opinion—securing co-operation and higher standards of conduct in regard to litter and other forms of vandalism in the Park areas. The form of administration is important, however, when a clash arises between some immediate interest of the local community or the specific requirements of a government department or national corporation and the national interest in the preservation of amenity which the National Parks Commission was established to safeguard. Moreover, while the local authorities are even less able than the National Parks Commission to resist the pressure of the powerful nationalized corporations and government departments, the omission to provide the National Parks Commission with adequate financial resources and staff of its own increases the risk of conflict between the local authorities and the Commission.

The fact that such unsatisfactory systems as that adopted for the Snowdonian National Park have worked rather better than could have been expected does not affect the main point: apart from the absence of an adequate overall view, and greater danger from the operations of the Electricity Authority or Service Departments, for example, the local authorities are, at best, subjected to an unreasonable strain between local and national responsibilities; at worst, relations between them and the National Parks Commission can be exacerbated and deadlock ensue.

Ample evidence of this is provided by the present report. There is no mention in it of the project for a Cornish National Park, negotiations for the boundaries of which began nearly three years ago. In its previous report the Commission referred to the recommendation of the Cornwall County Council that the project should be deferred *sine die*. The Commission then recorded its refusal to acquiesce in a proposal to suspend the intentions of Parliament in this way; but there is no hint in the present report as to when the Commission proposes to renew the discussions, and neither in its retrospect nor in its prospect does the Commission judge the flouting of Parliament by local authority important enough for comment.

Exmoor provides another example of failure to reconcile the divergent views of county councils and the Commission; but here the Commission has proved less acquiescent and proceeded with the designation. The designation order, after a public inquiry in June 1954, was confirmed by the Minister without modification on October 15, 1954. It should be noted, moreover, that, while the designation order was opposed by the Devon and Somerset County Councils and the Williton and Dulverton Rural District Councils, it was supported by the Lynton and Minehead Urban District Councils. Again, the Commission is disappointed at the slow progress in creating footpath agreements in regard to the long-distance routes; no fresh proposals have been submitted for such routes. With regard to the path along the south coast of Cornwall, which, when complete, will give, with that already approved on the north coast, some 270 miles of continuous path around the whole coast-line of Cornwall, the Ministry has taken the initiative in approaching the local authorities concerned in giving assistance and urging them to complete the work as soon as practicable.

It is obvious that finance is a major factor, both in the slow progress with the long-distance routes and in the attitude of some local authorities to the

* National Parks and Access to the Countryside Act, 1949. Fifth Report of the National Parks Commission for the year ending 30th September 1954. Pp. iv+56+8 plates. (London: H.M. Stationery Office, 1954.) 3s. 6d. net.

designation and administration of national parks. If the National Parks Commission were provided with adequate resources and the local authorities were no longer liable to be called upon to finance national projects out of local rates, the extent to which co-operation already exists, and the support which the preservation of amenity already enjoys, indicate that with the disappearance of the clash of interests and loyalties much more rapid progress would be possible. Apart, however, from noting that the Minister of Housing and Local Government has now made regulations authorizing the payment of exchequer grants to local authorities towards the cost of carrying out certain specified duties in national parks, the report scarcely refers to the financial aspect. The campaign for the use of the National Land Fund, as was originally intended, to finance national park operations is never mentioned.

The concern of the Commission over the slow progress in creating footpath agreements, however, does not arise from financial considerations. This is well brought out by the Pennine Way, for which only twenty-four and a half more miles of rights-of-way have been acquired, leaving some thirty-eight and a half miles to be acquired. The difficulties which arose during the year in regard to three sections of this route were all in relation to alleged risks of pollution of water supply. One in the area of Holmfirth Urban District Council resulted in the Minister's upholding the Commission that, in view of the Huddersfield Corporation's resources of long storage, filtration and sterilization, the risks of harming the purity of supply were too remote to justify abandoning a route devised for the safety of walkers. The Commission still hopes to find a path in the area of the Colne Valley Urban District Council which will be acceptable to all parties; but the third dispute, in relation to a proposed path in the area of Crowden in Longdendale, raises difficulties which are exacerbated by the Minister's decision, announced on December 30, 1954, to uphold the objection of the Manchester Corporation.

Mr. Duncan Sandys's decision was based on his acceptance of the evidence that in certain circumstances the waters from Crowden Great Brook pass quickly into the public water supply, the safety of which then depends solely on the sterilization and on the original purity of the water. Quite correctly, the Minister refers to the stress laid by the Gathering Grounds Sub-Committee of the Central Advisory Water Committee in its report seven years ago on public access to gathering grounds, on the wisdom of having several lines of defence for the protection of public water supplies; but one of the reasons given in that report for permitting public access was that the most stringent control of public access could not eliminate risk of contamination, and that other means of protection were desirable. Restrictions on public access were rejected because, while fallible, their imposition was liable to cause ill-will and reduce respect for more important restrictions.

While disregarding the advice of independent expert opinion in this way, the Manchester Corporation has adduced no convincing fresh evidence that the risk of contamination is serious, and it ignores the risks attached to footpaths which are much more frequently used both in the Greenfield and Longdendale valley in the Thirlmere and Haweswater catchment areas. The acceptance by the Minister of the Manchester Corporation's proposal carries disturbing implications. This reversal of a policy pursued without demonstrable risk for more than half a century and supported by independent expert opinion will not engender the goodwill and public co-operation on which the Heneage Committee rightly laid stress. Moreover, the absence of any attempt to deal urgently and effectively with the risk which the Corporation alleges to exist, by means which expert opinion regards as effective, exposes the Corporation to adverse comment."

The observations of the National Parks Commission on the decision have yet to be made public; but the situation will doubtless be discussed in its next annual report. Meanwhile, the scientist will note a further example of the disregard, by a local authority, of expert opinion and national interests when they clash with local convenience or interests. The Minister's decision, moreover, will arouse doubts as to the soundness of his concern for the purity of public water supplies and the genuineness of his interest in access to the countryside.

There is some slight resemblance between this dispute and that over the erection of a television station at Hessary Tor in the Dartmoor National Park, where the Minister's decision to grant permission, subject to agreement, *inter alia*, on details of siting with the local planning authority, also runs counter to technical advice submitted on behalf of the National Parks Commission by Sir Robert Watson-Watt. The Commission is clearly unhappy at this over-ruling of the claims of amenity in a national park area. It observes in another connexion, when the local authority reversed an agreed decision: "if all planning authorities acted in this way, amenity considerations would be likely to receive little more than lip service, since all an Electricity Board would need to argue, in order to bring the authority to consent to a particular scheme, is that they will not proceed unless they are allowed to do so in the way they proposed".

Parliament, however, has made the National Parks Commission responsible for bringing to the attention of Ministers any development the effect of which appears likely to prejudice the beauty of any area, especially where that area is in a national park. Planning authorities carry a similar responsibility for their own areas, and the Commission rightly holds that that duty is not properly discharged unless the claims of amenity are placed before Ministers with the right degree of emphasis. That would indeed ensure that the responsible Minister is in possession of all the pertinent evidence, where various public interests are in conflict, before arriving at a decision. It does nothing, however, to remove the objection that the responsible Minister may be judge in his own cause.

In addition to more than one thousand proposals for electrification referred to the National Parks Commission for comment during the year by various area boards, the Commission was consulted by the British Electricity Authority on national electricity schemes relating to power-stations or the super-grid. The Commission recognizes that the area boards are not unresponsive to the claims of amenity, and usually the Commission has been able to assent to the proposals or to agree on modifications which have lessened the damage to the amenities; though it must be admitted also that sometimes the authority or the boards have been negligent in their public relations duties. Nevertheless, the Commission is sometimes obliged to dissent, and it is now apparent that, particularly in relation to proposals for overhead lines, the Commission is, in present circumstances, liable to be placed in an impossible position. Where the electricity authority refuses to proceed because of the additional expense of putting cables underground, the National Parks Commission is faced with either abandoning its responsibility for the protection of amenity, or the areas concerned may be deprived indefinitely of electricity supply.

What is involved is well shown in the dispute over the supply of electricity to Borrowdale, Patterdale and Langdale in the Lake District National Park. The Commission refers to the Borrowdale and Langdale schemes in the present report, and the proposed supply schemes are being discussed with the Lake District Planning Board. The North Western Electricity Board has, however, since submitted to the planning board a scheme for extending the supply line in Patterdale which will involve more than four and a half miles of new line, all carried above ground on poles or pylons. Mindful of its statutory duty, the planning board has suggested instead that the line shall run underground for three of its four and a half miles. What is said in the National Parks Commission's report indicates that the electricity board is likely to answer that if the line is put underground the whole of the additional cost must be borne by the individual customers supplied and that it cannot be spread over a larger area. Few of the prospective customers, some of whom have been waiting for thirty years for the supply, can afford to pay several hundred pounds extra, and unless the planning board gives way, the scheme will be dropped again. The position is aggravated in the Lake District, because, unlike some regional electricity authorities, the North Western Electricity Board has consistently declined to spread the cost of a short stretch of underground line over the whole of a large project. In consequence, if the planning authority refuses to sanction overhead lines, the electricity board refuses to proceed: there is no public inquiry at which the matter can be thrashed out, and the planning authority incurs obloquy for doing its statutory duty.

This dilemma, however, is arising repeatedly, and not only in the Lake district; like the clash over the administration of the national parks, it arises essentially because the National Parks Commission and the national park boards have no real financial resources of their own. It is reasonable enough to argue that when the national interest in natural beauty conflicts with some local need like that for cheap electricity, the extra cost of reconciling beauty with the local need should be met by some contribution from national funds. The National Parks Commission and its various Park Planning Boards would be the logical instruments for any such payments; but they have neither the statutory powers to make payments, nor the resources from which to do so, at any rate until the National Parks Commission receives the assistance from the National Land Fund or some such source which Mr. Hugh Dalton specifically promised when the National Parks and Access to the Countryside Act was passed.

The National Trust and the Youth Hostels Association are already benefiting from the National Land Fund, and it has been strongly urged that the National Parks Commission should be supported from the same source. Adequate finance would go far to remove some of the existing opposition to the work of the Commission and would facilitate a more vigorous educational campaign to remove misunderstandings which hinder it and prevent the full public co-operation upon which the success of its work ultimately depends. Perhaps the most discouraging feature of the present report is that the Commission seems to accept tacitly the parsimony which thus hinders its work—which has delayed into its fifth year, for example, the appointment of a second assistant field officer, bringing its technical staff to three.

There is in this report ample evidence of successful efforts to prevent or minimize disfigurements of natural beauty, of co-operation from local authorities and other public bodies and quiet persistence in the task of public education. The Commission itself recognizes that its efforts to make the national parks better known and understood require increasing help from other bodies and individuals concerned with the beauty and preservation of the countryside, and that much has still to be done, especially among young people, to create a wide public awareness of the nature and purpose of the national parks in Great Britain. But one looks in vain in this report for any evidence that the preservation of amenity is regarded as a real national interest by the Minister himself, still more by the Government as a whole. While, however, the Government regards national parks or nature reserves and the preservation of natural beauty as something to which no more than lip service need be given, the danger persists that departmental interests will irretrievably destroy them. No ministerial discouragements can really absolve the National Parks Commission for its failure, in reviewing the first five years of its work, to insist on the over-riding need for a short amending measure to the Act, which, taking into account that experience, would endow the Commission with the financial resources it needs, and help to restore its pioneering spirit.

PHYSICAL CHEMISTRY OF HIGH POLYMERS

Principles of Polymer Chemistry

By Prof. Paul J. Flory. (The George Fisher Baker Non-Resident Lectureship in Chemistry at Cornell University.) Pp. xvi+672. (Ithaca: Cornell University Press; London: Oxford University Press, 1953.) 68*s*. net.

IN 1935, the Faraday Society held a General Discussion on the subject of polymerization and condensation. At that time it was still possible to debate seriously whether natural and synthetic polymers could properly be regarded as strictly comparable materials, the properties of which were to be understood in terms of ordinary physicochemical principles, applied to long-chain molecules. This Discussion may be considered to mark the beginning of the surprising growth of polymer science which has taken place in the past twenty years. This same period coincides with the research activity of Prof. P. J. Flory, who now, in the book under review, presents a systematic account of these developments. Flory's own contributions to polymer science have been both profound and extensive. In 1937 he set out clearly the now generally accepted principles of vinyl polymerization processes. In 1942, he evaluated the entropy of mixing of high polymers with liquids. He has made notable contributions to our understanding of the equilibrium and flow properties of polymer solutions, of polymer crystallization, and of rubber elasticity. A book by Flory will therefore command wide attention, and it is safe to say that its readers will not be disappointed.

The plan and scope of the book reflect the author's interests, and, as its title indicates, it is concerned with physico-chemical principles rather than with the presentation of detailed factual information. As a text-book for a postgraduate course on polymer science it could scarcely be bettered, while as a reference book it provides a theoretical background to current research activity and applications of high polymers.

Following two introductory chapters, the author deals first, in Chapters 3–5, with the mechanisms and kinetics of polymerization reactions, discussing in turn polycondensation, free-radical polymerization, copolymerization, and (briefly) ionic polymerization. These chapters, in conformity with the plan of the book, discuss the principles involved, and quote ample illustrative data, but do not compete with or replace the more specialized texts on polymer reactions.

The next main section of the book (Chapters 6–9) is broadly concerned with the structure of polymers, both linear and cross-linked, with especial reference to the determination and distribution of molecular weights. The various experimental techniques are adequately outlined; but the main thread of argument is provided by thorough discussion of the principles of the methods, the origins of molecular-weight distribution, and the correlation of theory with experiment. The application of these methods to specific polymers and the compilation of detailed results have very reasonably been held to lie outside the scope of the book.

In Chapter 10, the author turns to the problem of chain configuration, outlines the random flight approximation and discusses briefly some of the restrictions imposed by bond angles and rotation barriers. Discussion of rubber elasticity follows naturally in Chapter 11, and here, as elsewhere in the book, the author has chosen to develop the subject simply and systematically without interrupting his argument to discuss disagreements in points of detail which have been expressed by different workers in the field.

Chapter 12 contains a statistical derivation of the thermodynamic properties of polymer solutions. The limitations of the elementary lattice treatment are dealt with and the excluded-volume problem discussed by Flory's own method based on the analogy between polymer solutions and imperfect gases. The usefulness and power of these methods are illustrated by reference to a few well-chosen examples.

Chapter 13 is entitled "Phase Equilibria", and is concerned in the main with the applications of the results of Chapter 12 to problems of polymer solubility, fractionation and swelling. Polymer crystallization is discussed in a surprisingly short section of a dozen pages.

The final chapter contains a concise but very satisfying account of the important though difficult problem of the viscosities of polymer solutions. Here, as throughout the book, the treatment is essentially original, the contributions of various workers being interwoven and often illuminated by the author's systematic presentation. No attempt has been made to review the vast literature which has grown around the empirical use of viscosity as a measure of molecular weight.

This book can be unreservedly recommended to beginners and experts alike. Although it would be easy, as the author himself points out, to mention subjects which have been omitted, the field covered is very broad. Readers unfamiliar with the methods of statistical thermodynamics will find some sections difficult without supplementary study, but physical principles are never submerged in mathematics. Clarity of expression and depth of physical insight are outstanding characteristics of the book, as they have been of Flory's research papers. All workers in polymer science owe him a debt of gratitude for this monograph.

G. Gee

MAXWELL'S THEORY AND SOME OF ITS APPLICATIONS

Electromagnetics

By Prof. John D. Kraus. (McGraw-Hill Electrical and Electronic Engineering Series.) Pp. xiii+604. (London: McGraw-Hill Publishing Co., Ltd., 1953.) 76*s*. 6*d*.

MANY years ago, the reviewer overheard a conversation between two colleagues about a recently published book, when one of them remarked: "If one masters Maxwell's theory the book can be read like a novel". At that time there were not many people who could boast of mastering this theory. Some years earlier, as Michael Pupin tells in his autobiography, he came to England and tried to get information about Maxwell's theory but could not find any university here to help him and had to go to the Continent and to study with Helmholtz. But times have changed since then, and there exist at present, besides Maxwell's original work, which perhaps is not easily understood, quite a few comprehensive treatises on electromagnetic theory.

In spite of this fact, the book under notice should have many readers who want to acquire a sound foundation for a thorough knowledge of the subject. It is written in a fluent style by a scientist possessing outstanding pedagogic skill. It is intended for students acquainted with general physics, the elements of calculus and to some extent with vector analysis, although vector concepts are lucidly developed in the book so far as they are needed. But the book is also very suitable as a work of reference for research workers. The author stresses throughout the importance of using dimensional relations of the quantities concerned for checking the correctness of equations between them. The rationalized Giorgi system of units is applied based on the metre, kilogram and second, with the coulomb used as fourth fundamental unit.

The book contains nearly four hundred well-chosen and very clear illustrations, many worked examples within the text and numerous problems at the end of each chapter. Field mapping methods are shown in their application to electric and magnetic fields as well as to current, heat and fluid flow.

The first two chapters deal with the static electric field, starting with Coulomb's law and deriving Gauss's law on the relation between electric flux density and charge. In the second chapter the capacitor, coaxial, two- and single-wire transmission lines, Maxwell's divergence equation and the equations of Poisson and Laplace are discussed. In the third chapter, dealing with the steady direct current, the laws of Ohm, Kirchhoff and Joule are discussed and the relevant current parameters are defined. Finally, Laplace's equation for conductive media is given. The fourth and fifth chapters deal with static magnetic fields in air and in ferromagnetic materials, respectively. The magnetic field is here introduced not as that of a permanent magnet but as that produced by a steady current, while permanent magnets and Coulomb's law for magnets are dealt with much later. Flux and flux density, magnetic moment, solenoids, inductors and inductance, permeability, magnetizing force and magnetomotive force are defined. Then Biot-Savart's and Ampère's laws are stated in the usual form and, after a brief explanation of the vectorial product and its properties, also in vector notation. Ampère's law is given connecting the magnetizing force of a loop with the current enclosed and, after explaining the notion of curl, it is stated in the form given by Maxwell though in the more modern vector notation. In the sixth chapter the effect of electric and magnetic fields on charged particles is discussed and the cathode ray tube, the cyclotron and the mass spectrograph are treated as examples. While these first six chapters were concerned with static and steady states, fields changing with time are introduced in the seventh chapter. Faraday's law and its mathematical expression due to Maxwell are given, and the betatron and the fluxmeter for the measurement of magnetic fields are briefly described. Here, as elsewhere, Maxwell's notion of the displacement current is given due consideration.

Chapter 8 gives a summary and tables of all the Maxwell equations in their integral and differential forms, first for the general case, then for free space, for harmonic variation and for steady and static states.

The rest of the book is dedicated to selected applications of Maxwell's theory. In Chapters 9 and 10 the plane waves in dielectric and conducting media are discussed, wave equations are derived and some of their solutions are given. The difference between phase velocity and group velocity is lucidly illustrated by the movement of a caterpillar. The Poynting vector and its uses are introduced. Chapters 11–13 deal in greater detail with transmission lines, with wave guides and antennæ respectively, and the last chapter is devoted to boundary-value problems. At the end of this chapter a brief introduction is given to the method of conformal transformations.

As in dealing with the solution of wave equations in cylindrical and spherical co-ordinates use is made of Bessel, Neumann, Hankel and Legendre functions, these are briefly discussed and partly illustrated in the appendix. Besides this, the appendix contains a detailed table of the units used and their dimensions, a section on field-mapping technique, a table of dielectric materials and various mathematical relations. A bibliography and a combined name and subject index conclude the book.

This survey of the contents of the book shows how much information can be found in it. Two slight omissions may be noticed. In dealing with the Poynting vector, a conversion formula is used connecting the divergence of a vector product with the curls of its factors. The formula is also to be found in the appendix, but no proof is given for it. Of course, it may be verified easily by applying the definitions of divergence and curl and the rules given in Chapter 4 for the cross-products of unit vectors. Also the vector identity used in the section on the general development of the wave equation is not proved. Perhaps in a second edition the proofs might be given in the text or used as set problems in Chapter 4. But these are very minor criticisms of a well-produced book which may be strongly recommended.

R. NEUMANN

AUSTRALIAN ORNITHOLOGY

The Literature of Australian Birds

By Major H. M. Whittell. Pp. 788+32 plates. (Perth, W. Australia: Paterson, Brokensha, Pty., Ltd., 1954.) £A.3 10*s*.

ALTHOUGH Australia has been settled by Europeans since 1788, little serious attention has been paid to the study of its birds. For this there are two primary reasons. First, there has been in Australia no hard core of scientifically trained zoologists interested in the group: such people, in a young country, have generally almost inevitably gravitated into economic zoology. Secondly, bird-watching has never become popular. In some respects this is very good, in that it makes it possible, in an Australian capital city, for an experimental scientist to trap sparrows, starlings or other pests without being assailed by protesting fanatics. In another respect, it is unfortunate in that there has never developed there any large corpus of serious and gifted amateur ornithologists of the sort who have done such valuable work in Great Britain in the past fifty years.

So it is that the late Major H. M. Whittell has been able to include the whole literature of Australian birds from 1618 to 1950 in one moderately bulky volume. This fine bibliography is the result of many years painstaking work in metropolitan newspapers as well as technical journals. The perusal of the former is a sad necessity because the press of early Colonial days sometimes published the initial

descriptions and names of new (or supposedly new) species given by pioneer museum men who rushed accounts into local newspapers in order to get priority.

Major Whittell's book is divided into two parts covering the periods 1618–1850 and 1850–1950. The first is of particular interest in that it deals with the accounts of the great naturalist-explorers in what can almost be called the pre-laboratory era. It relates little-known information brought back by the early Dutch navigators, including the log-record of Antonie Caen, of the *Banda*, who in 1636 found (as did De Vlaming, of the *Geelvinck*, sixty years later) that the supposedly fabulous black swan was a reality, and not even a rarity, after all. There is included, too, much of other early information brought to Europe by French naturalists, and by the English buccaneer Dampier, and, of course, that obtained by Cook on his various voyages. There are data recorded by gifted early convicts and free-settler artists and naturalists; and the labours of Robert Brown (of Brownian movement), Charles Darwin, T. H. Huxley and many others have not been forgotten.

The second and longer part is devoted to the condensed autobiography and complete bibliographies of individual naturalists.

"The Literature of Australian Birds" will be, no doubt, expanded as new documents come to light; but it is unlikely to be replaced and must, in fact, be indispensable to anybody interested in ornithology of the Australasian region. It is much to be regretted that its author, an English officer who first studied zoology in his youth under Cossar Ewart, and who decided to live in Australia after the First World War, did not live to see its publication. The only serious defect in the first edition is the lack of a species index. It is sold in paper covers in order to reduce expense.

A. J. Marshall

DEVELOPMENT OF INDIAN PHARMACY

History of Indian Pharmacy

By G. P. Srivastava. Volume 1. Second edition. Pp. xvi+277. (Calcutta: Pindars, Limited, 1954.) 12 rupees, 8 annas; 2.50 dollars.

THREE different systems of medicine have been practised in India since early times. The most ancient system, the Ayurvedic, was the original system which owed nothing to external influences. It was practised until about the end of the twelfth century A.D. From that date until the end of the eighteenth century it was augmented or supplanted by the Arabian system, the Unani Tibi. At the end of the eighteenth century the modern Western system was introduced by the British. The first volume of this work—all that is published so far—deals only with the Ayurvedic system, and this second edition has followed very rapidly on the first.

The two great works of Indian medicine are the Charaka-Samhita and the Susruta-Samhita. The eight sections of Charaka's work deal fairly comprehensively with the preparation and use of drugs, and the treatise by Susruta extends this practice and also deals with surgery. There have unfortunately been wide discrepancies in the dates assigned to these two treatises. The author adopts the dates 1000–800 B.C. for Charaka and 1000–600 B.C. for Susruta. In his foreword, Dr. Urdang points out that the Chronology Committee of the National Institute of Sciences in India has recently accepted the dates A.D. 100 for Charaka and A.D. 200–500 for Susruta. Reference shows, however, that the report of the Committee which Dr. Urdang quotes is very brief, and it obviously indicates that the Committee based its findings largely on the fifty-year-old work of Winternitz. This matter is important in view of the possibility of the influence of Hindu medicine on the Greeks. The author contributes a few interesting points to this practically insoluble controversy.

In writing this book, Mr. G. P. Srivastava has leaned rather heavily on the standard works by Mukhopadhyaya, Dutt, Ray and others. But these works are now difficult to obtain, and the author has rendered a service by providing something more than a summary of the available material. Its value compensates for the slight quaintness of the English. It should be corrected by a European scholar before the next edition, and obvious misprints and errors—such as the 'three' humours of the Greeks, 'Gallen' for 'Galen'—should be removed. Despite these blemishes this book, which is written with enthusiasm and sincerity, will be found useful. There is an excellent index.

E. Ashworth Underwood

PROJECTIVE AND METRIC GEOMETRY

Projective Geometry and Projective Metrics

By Herbert Busemann and Paul J. Kelly. (Pure and Applied Mathematics Series.) Pp. viii+332. (New York: Academic Press, Inc.; London: Academic Books, Ltd., 1953.) 6 dollars.

MUCH of this book differs widely from other treatises on geometry. The first three chapters are on lines which are now usual. Projective geometry is treated from the algebraic point of view. The authors consider that synthetic methods have lost their appeal for the present generation, especially in the United States, where there is a tendency to consider generality as the only criterion of value. After two chapters dealing with lines and conics in the projective plane, there is a third chapter dealing with the closely related affine geometry. The surprise for the reader comes in Chapter 4. This opens with a discussion of abstract metric spaces, in which for every two points there is some definition of distance, though possibly quite different from the usual one. From the great variety of such spaces two special kinds are distinguished—Minkowskian and Hilbert's. Euclidean geometry reappears as a particular case of Minkowskian, and the non-Euclidean hyperbolic geometry of Lobachevsky is a particular case of Hilbert's. The fifth chapter considers non-Euclidean geometry, both hyperbolic and elliptic, in detail. In these two chapters there is a good deal about motion, area and perpendiculars.

The sixth and last chapter, entitled "Spatial Geometry", extends the results of the preceding five chapters from two to three dimensions; but it is written in a different style, intended as seminar work for the more mature student. Instead of the explicit exercises of the preceding chapters, the student is here asked to supply for himself the proofs of many of the theorems. The book concludes with a short bibliography and an eight-page index.

H. T. H. Piaggio

Seismic Prospecting for Oil

By C. Hewitt Dix. (Harper's Geoscience Series.) Pp. xx+414. (New York: Harper and Brothers; London: Hamish Hamilton, Ltd., 1953.) 63*s*.

AMONG geophysical prospecting methods, the seismic has now, and will probably retain, a favoured position ahead of all others. Gravity, magnetic and electric methods have their value; but successful interpretation is very uneven. Recently, airborne magnetic surveys have given some useful general indications, but too much should not be claimed; Dr. Dix writes that their value "can hardly be overestimated", surely an over-statement of considerable splendour.

The success of the seismic method has been outstanding; but failures have also been many and costly. Where conditions are simple and favourable, high-grade reflexions are obtained and no great skill is required to read the records, as with echo-sounding at sea where there is only one reflector and one simple medium. At the other end of the scale, structure and strata may be so complex that the method must accept defeat; but the average experience is intermediate. Many apparent seismic failures are, in fact, failures of interpretation; the more complex the conditions the more the skill required of the operator and the greater the personal factor in the final appraisal. The chapters on interpretation, embodying the author's considerable experience, are the important practical contributions of this book; for the rest it has the marks of hasty assembly and, by the author's own admission, was dictated around his text figures. The concluding section is a summary of the basic physics "written primarily for seismologists interested in the interpretation of seismic results"—implying that many are not so interested.

[The late] G. M. LEES

General Chemistry

By Prof. W. F. Luder, Dr. Arthur A. Vernon and Prof. Saverio Zuffanti. Pp. xiii+595. (Philadelphia and London: W. B. Saunders Company, 1953.) 30*s*.

IN this introductory chemistry for American university students, the authors cope with the vastness of the science by laying special emphasis on those theoretical ideas which are of great significance for the understanding of chemical behaviour. Accordingly, after five chapters on elementary terms, processes and definitions, they build into a light framework of illustrative matter a thorough treatment of the periodic system, the electronic theory of valency and the new conceptions of the terms acid and base. Other points of theory are included but not treated so fully. Moreover, for their instructional value, attention is directed to the worth of Gardner's form of the periodic table—more customary forms are also given; to the system of exhibiting the properties and relationships of the elements by the author's atomic structure chart; and to such helpful generalizations as the classification of the elements based on the positions of the differentiating electrons.

The conception of an acid is treated in an equally thorough way and includes the discussion of the water, the proton and the electronic definitions. Then, in the next twenty chapters, appropriately intermingled with more theory, the elements in their periodic groups are briefly studied. After this we find four chapters on organic chemistry, one on analysis, and six on the metals. The lanthanide and actinide series are included, and there is a good and unusual chapter on the systematic properties of related and similar metals. Copious illustrations, sets of questions, numerous references to supplementary reading—many from the *Journal of Chemical Education*—and the use of the electronic theory throughout the book, combine to make this a stimulating text for first-year university students or for those studying for university scholarships. G. FOWLES

Detailed Descriptions of Varieties of Wheat, Barley and Oats recommended by the National Institute of Agricultural Botany

Pp. 98. (Cambridge: National Institute of Agricultural Botany, 1954.) 20*s*.

THIS publication, giving the full descriptions of the fifty cereal varieties on the Recommended Lists of the National Institute of Agricultural Botany for 1954, takes the form of a loose-leaf pocket handbook. A single page is devoted to each variety so that reference is simple, and additions or deletions readily made, for it is hoped to prepare further pages when new varieties appear on the Lists. Since it is primarily intended for use by inspectors of seed crops for identification purposes, the greater part of the information is concerned with the detail of the inflorescence and grain. Excellent explanatory diagrams showing the main recognition characters, and a glossary of the more important botanical terms are included to help the less highly trained reader. The publication should also be valuable as a general reference book, for under the heading "General Information" a brief account is given of the origin of each variety and its properties, such as maturity date, disease resistance and tendency to lodge or sprout in the ear. In addition, there are comments on milling, baking, malting and brewing qualities. It does not, however, attempt to replace the current leaflets of the Institute, to which reference for full particulars of the use of the varieties should continue to be made. The handbook is a convenient size, printed on good paper, with a strong, serviceable cover. K. W.

The Pocket Guide to Nests and Eggs

By R. S. R. Fitter, assisted by the Hon. Guy Charteris. Pp. xv+172+48 plates. (London: William Collins, Sons and Co., Ltd., 1954.) 21*s*. net.

THE beginner in bird study, whether young or not so young, has no lack in these days of books to help him on his way. This book is frankly for the tyro, to whom it should be of considerable assistance; but experienced field naturalists will also find it of interest. However, it was obviously the needs of the novice that the author had in mind, as witness the way his descriptions are divided into "Land Birds", "Waterside Birds" and "Water Birds", and each section is further subdivided into 'very short', 'short', 'medium short', 'medium', etc. Mr. Fitter's descriptions of nests and eggs, in which he has been assisted by Mr. Guy Charteris, are concise and accurate, while Mr. R. A. Richardson has supplied excellent colour plates, black-and-white plates and line drawings in the text, though the exigencies of colour reproduction have been a little unkind to the artist here and there; for example, the much too scarlet breast of the robin and the bright red flank of the redwing. Nevertheless, the book should achieve its object and help the novice name the nest and eggs he discovers in the course of his rambles.

FRANCES PITT

FIRST OBSERVATIONS ON A LIVING CŒLACANTH

By Prof. J. MILLOT
Director, Institut de Recherche Scientifique de Madagascar

THE organization for the fishing and conservation of the Cœlacanths of the Comoro Islands created by the Institut de Recherche Scientifique de Madagascar, with the invaluable support of the Administration supérieure and of the Commandement de l'Air, reports a new success: on November 12 last a further *Latimeria* was captured at Anjouan. This brings the total since 1938 to eight and is the finest yet, as regards both size and state of preservation, and by far the most interesting because it is the first near-adult female specimen which has come into our hands as well as the first of these precious fishes which anyone has been able to observe alive; for although an Italian expedition claimed to have photographed one last year, at 15 metres depth, the circumstances were quite incredible.

As a matter of fact the principal objective, once an adequate number of specimens for anatomical investigation had been acquired, was to capture a living one and keep it alive sufficiently long to make the biological observations desired. This was a difficult proposition. Hitherto, almost as soon as the fish had been brought to the surface, the fishermen had promptly battered it to death with oars or dispatched it with harpoons or knives in order to prevent it from struggling, and to be able to hoist it into their narrow pirogue without too much trouble. We had to put a stop to this deplorable behaviour and, on the contrary, persuade them to do their utmost to bring the fish, alive and uninjured, to the nearest harbour. This they were never willing to attempt, fearing, not without good reason, that on the way a shark or a shoal of barracuda might wrest their prize from them and lose them the promised reward. It took a great deal of persuasion to obtain their compliance, with an express promise that should they be successful the reward would be doubled.

We, for our part, had to ensure a prison containing a sufficient quantity of sea water for the captive fish. At first the provision of a fishpond on the seashore was considered; but on these rugged shores the work of constructing one would certainly be difficult. That solution had, besides, the inconvenience of creating a predetermined and immovable rendezvous although the place of the next capture could not be foreseen. Used as a kind of aquarium, a sunken small boat seemed to have many advantages to commend it—cheapness, simplicity, rapid installation, mobility—and it was decided to adopt this course.

The eighth *Latimeria* was pulled in from 140 fathoms depth (255 metres) at 20.00 hr. on November 12 by a fisherman, Zema ben Saïd Mohamed, assisted by Madi Bacari, both of the Maijihari quarter of Mutsamudu. Their pirogue was then about 1,000 metres offshore, opposite Mutsamudu jetty. The sea was very calm and the tide ebbing; it was two days after full moon and the moon had just risen.

By the way in which the fish had taken the bait, the usual hunk of 'roudi' (*Promethichthys prometheus* (Cuvier)), Zema, an excellent fisherman, immediately guessed that it must have been a Cœlacanth. Nevertheless, he took half an hour and every precaution over hauling it in and, having made sure that it really was a *combessa* (the local name for the fish), he decided to try for the double reward by keeping it alive. He succeeded, "en le tenant par la main", as he said, in passing a cord in through its mouth and out through the gill-opening, and by means of this cord and of the line (which remained attached to the centre of the anterior part of the floor of the mouth) he led the creature all the way back to Mutsamudu jetty; though sometimes it was the fish that towed the pirogue.

Administrateur Lher, as soon as he had been notified (it was by then 20.50 hr.), decided, as we had agreed in advance, to sink a whaler immediately in which to place the *Latimeria* and keep it under the least unfavourable conditions practicable. The receptacle was ready by 21.30 hr. and anchored at a few tens of metres off the end of the jetty. The basin of sea water so contrived measured about 7 metres long by 1½ metres wide and 80 cm. deep. The bung had been removed from the bottom of the boat, so as to provide a small but continuous current of water. Besides this, every half-hour the boat was violently rocked in order to renew the greater part of the water. A net covered the top of the whaler to prevent the Cœlacanth from escaping, which it never seemed to want to do. The greenish-yellow luminescence of its eyes was very pronounced and could be seen at quite a distance. The colour of the fish was very dark greyish-blue, recalling that of the steel of a watchspring, with fins having clearer grey-bluish reflexions.

Throughout the night—which the delighted population of Mutsamudu passed in singing and dancing to celebrate the capture—the Cœlacanth was watched over with admirable care by the chef de circonscription, taking turns with his adjoint, M. Solère. It seemed, although quite bewildered at the sequel to its ascent to the surface, to be taking the situation very well, swimming slowly by curious rotating movements of its pectoral fins, while the second dorsal and anal, likewise very mobile, served together with the tail as a rudder.

After daybreak it became apparent that the light, and above all the sun itself, was upsetting the animal very much, so several tent canvases were put over the boat to serve as some kind of protection. But despite this precaution and the more or less constant renewal of the water, the fish began to show more and more obvious signs of distress, seeking to conceal itself in the darkest corners of the whaler.

At 14.45 hr. it was still swimming feebly; but at 15.30 hr. it had its belly in the air and only the fins and gill-covers were making agonized movements.

It was then covered with a sheet and taken immediately to the hospital. There was not a scratch on it, apart from a tiny incision in the centre of the anterior part of the floor of the mouth made by the fisherman when recovering his hook. Altogether, it was in remarkably good condition, without any rupture of the viscera or suffusions of blood.

It measured 1·42 m. in length and weighed 41 kgm.

Chemical and histological investigations could be made under the best possible conditions on perfectly fresh tissues.

Notified by telegraph of the capture and rushed from Tananarive by a special aircraft, I arrived just in time to witness the last moments of the fish.

Two principal conclusions emerge from the corroborated statements made by local observers and by myself: (1) the extreme photophobia of *Latimeria*—the sunlight seemed literally to hurt it; (2) the exceptional mobility of the pedunculate fins, correlated with the wealth of musculature which is revealed by anatomical studies. The pectorals, in particular, can move in almost any direction and show themselves capable of assuming practically every conceivable position.

There can be no doubt that death was brought about by decompression combined with rise in temperature. The previous water-samples taken by Menaché (1953) and by Millot and Cousteau (1954) in the precise positions in which previous captures had been effected showed important temperature differences between the stratum frequented by the Cœlacanths and the surface water (26° C., more or less) during the daytime off Moroni or Mutsamudu.

It must also be noted that the *Latimeria*, which appeared greatly distressed on its arrival at the surface, seemed to have recovered appreciably after an hour or so and passed the rest of the night quite comfortably without any too obvious inconvenience. It was daybreak, with the appearance of sunlight and the gradual warming of the water, which initiated the progressive discomfort that led rapidly to its death.

The trial having thus been made under satisfactory conditions, it does not seem likely that substantially better results can be anticipated from the employment of the same technique in future. We must be prepared to make other arrangements. The only procedure offering any hope of keeping a live Cœlacanth for a longer time would seem to be the construction of a great trellis-work cage in which we could place the fish immediately after its capture; there we should keep it normally submerged at a depth of 150–200 m., and only haul it up for limited times when someone wanted to observe or photograph the animal. Such a cage will be put in hand at Anjouan.

[Translation by Denys W. Tucker, British Museum (Natural History).]

NUTRITIVE VALUE OF BREAD

THE controversy about the relative values of 'brown' bread and 'white' bread seems to be eternally with us, largely due to the failure of the protagonists on either side to appreciate that neither 'brown' nor 'white' is constant in composition and, still more important, that bread is rarely the only item in the diet. The nutritional value of a diet is, of course, determined by the total mixture of items in it, and their combined ability to meet the particular needs of the individual concerned. These needs are also not constant but vary according to age, sex, activity, body-size, phase of development, state of health, past history of the organism and present environmental conditions. Very few workers provide sufficient data about these various factors to permit valid comparisons between the results of one experiment and another, and it is a great pleasure to read the careful and closely argued report now presented by Widdowson and McCance dealing with the work they undertook in German orphanages after the Second World War*.

Five different flours were used: (1) 100 per cent extraction, (2) 85 per cent extraction, (3) 70 per cent extraction, (4) 70 per cent extraction enriched with thiamin, riboflavin, nicotinic acid and iron up to the level of whole wheat flour, and (5) 70 per cent extraction enriched with these four nutrients up to the level of 85 per cent extraction flour. All five were fortified with calcium carbonate. In one orphanage the flour (mainly in the form of bread) provided approximately 75 per cent of the total calories; in the other it provided only 35 per cent, extra fat and sugar being given to provide another 35 per cent, and the residue of the diet, in both cases, being made up from the German rations provided locally. In addition, all children were given daily vitamin supplements consisting of 2,000 i.u. of vitamin A, 1,000 i.u. of vitamin D and 25 mgm. of ascorbic acid.

Some three hundred children were involved (both boys and girls) between the ages of four and fifteen, and the experiments continued throughout one complete year. Many different observations were made, and a large number of chemical analyses were undertaken. The authors state that "During the preliminary period, before the main experiments began, measurements of height and weight and of the girth of various parts of the body were made. Each child was examined clinically, and a sample of blood was taken for the determination of hæmoglobin, hæmatocrit, serum protein and serum P-cholinesterase. Radiological examinations were made of the gastro-intestinal tract and of the bones, and the teeth were inspected. The children were weighed and measured every fortnight while the experiments were in progress, and they were examined clinically every three months. At the end of the experimental year all the examinations which had been made at the beginning were repeated. Studies of the intakes and excretions of nitrogen, minerals and of the B vitamins were also made on some of the children at intervals during the investigation".

The usual difficulty of a long-term experiment arose, namely, that individual children dropped out from time to time and so reduced the value of the initial matching of the different groups. The effects have, however, been carefully checked by various devices, and the authors are satisfied that it has not in any way invalidated their results.

The two most important general findings were: (1) that all the children did remarkably well; and (2) that no differences either in growth or in health could be detected between the groups receiving the different types of flour. This, of course, does not mean that one flour is necessarily as good as another but merely that, in this series of experiments, one diet was (apparently) as good as another. The qualification is necessary because there was some evidence that the children on the low bread diets (35 per cent of the total Calories) tended to become too fat, whereas the high bread diet produced a better all-round development. The authors themselves say: "The advantages of the [high-bread] diet would probably have become more obvious as the children approached maturity and might be still more striking in adult life".

* Studies on the Nutritive Value of Bread and on the Effect of Variations in the Extraction Rate of Flour on the Growth of Undernourished Children. By E. M. Widdowson and R. A. McCance. Medical Research Council, Special Report Series No. 287. Pp. viii+137+1 plate. (London: H.M. Stationery Office, 1954.) 8s. 6d. net.

At the beginning of the experiment the children were under-developed by comparison with American children of the same age ; but during the experimental year they grew at a greater rate and so decreased the differences. In spite of this stress of abnormally rapid growth, no signs of specific vitamin deficiencies were detected in any group at any time, and radiological examination showed that bone development kept pace with the rapid increases in height and weight. The only unsatisfactory finding was the prevalence of slightly enlarged thyroid glands, which persisted despite dosage of small amounts of iodine. The authors suggest that this may have been due to the high calcium intake. It is perhaps also possible that the diet included goitrogenic vegetables.

In general, however, it is clear that, on these diets, previously under-nourished children were able to make very satisfactory progress. At the end of the year, a supplementary trial was run and a group of children in the first home were given 500 ml. of reconstituted full-cream milk daily for six months. This produced no detectable difference in growth-rate or physical condition from the control group, which continued on the previous high-bread diet.

Several commentators have already expressed surprise that the diets used should have produced such good results, and the authors themselves seem to have expected something different. Yet, in both homes, the diets were considerably better than most children throughout the world normally grow up on, and there does not appear to be any need for revising our conception of requirement levels as a result of this work.

The diets were made up in the following way :

Daily intake (gm.)	No. 1	No. 2
Flour—		
100 per cent extraction	447	250
or 85 per cent extraction	437	—
or 70 per cent extraction	418	240
Potatoes	168	257
Fruit and vegetables	112	160
Meat, fish, cheese	24	34
Milk (mostly skim)	82	113
Butter and margarine	12	91
Sugar and jam	58	101

The children were able to eat to appetite and they averaged 2,000–2,500 Calories per head per day. In the first diet, animal protein averaged 8–9 gm., but total protein ranged from 61–73 gm. ; in the second, animal protein averaged 11 gm. and total protein 51–55 gm. In the first diet, fat averaged 22–29 gm. as against a pre-war average of 92 gm. for British children. Even so, however, it was considerably higher than the amounts commonly obtained by children in many under-developed parts of the world.

Ascorbic acid and vitamins A and D were maintained at a high level by the special vitamin supplements, and calcium by the addition of creta præparata (at varying levels) to all grades of flour used. Such supplementation is, of course, not normally available in other countries. The authors seem to think that the satisfactory bone and tooth development might not have been achieved without these supplements, and they point out that these may also explain the failure of the milk supplement to produce any further improvement, since "the present investigation is, in fact, the only one in which a milk supplement has been added to a diet known to contain plenty of calcium and vitamin D".

Increasing the refinement of flour (lowering the extraction-rate) primarily affects the values for iron, thiamin and nicotinic acid, and it is in relation to one of these that some evidence of deficiency might have arisen in the group receiving the refined flour. The most common defect of high cereal diets in other parts of the world, namely, a deficiency of riboflavin, might also have been expected in the high-bread group with their lower intakes of milk, meat and vegetables. Biochemical tests, however, showed that supplies of B vitamins were sufficient, but "the margin of reserve appeared to be small in the case of the children eating unenriched white bread. The supplies of riboflavin were probably nearest to the margin of safety".

An important and unfortunate aspect of this work is that the 70 per cent extraction flour that was used had a vitamin content above average for this type of flour. Had this not been the case, deficiency signs might well have appeared. Failure to appreciate this point will inevitably lead to unwarranted deductions being drawn from the findings presented in this report, despite the continually reiterated warnings of the authors. In fact, the results of these experiments amply confirm the wisdom of the Post-War Loaf Conference[1], which recommended that extraction-rates should not be permitted to fall below 80 per cent, and that an 85 per cent level was to be preferred.

The report contains a section dealing with the results of feeding the diets to laboratory animals, and several valuable appendixes by different authors setting out the detail of the biochemical and radiological investigations.

M. W. Grant

[1] Report of the Conference on the Post-War Loaf. Cmd. 6701. (H.M.S.O., 1945.)

A MANDIBULAR FRAGMENT, PROBABLY OF THE SALDANHA SKULL

By Prof M. R. DRENNAN and Dr. R. SINGER
University of Cape Town

In reconstructing the Saldanha skull-cap (see *Nature*, 172, 791 ; 1953), a few small fragments were temporarily left out, because we did not have all the pieces necessary to complete the 'jig-saw puzzle'.

Among these fragments was part of the ramus of a mandible with the coronoid process on it ; but its colouring, especially on its inner aspect, differed from that of the skull fragments, although the degree of fossilization appeared to be identical. It looked human, but it was somewhat out of the ordinary, and an extra measure of caution in identifying it was necessary, especially as it was found 500 yards away from the main fragments of the Saldanha skull[1].

Closer inspection has now convinced us that the specimen is human, and we consider that it probably belonged to Saldanha man. It has a morphology appropriate to the skull, and, by a coincidence, a small piece of human parietal bone was found with it. Both pieces were collected by one of us (R. S.), and it so happens that the parietal fragment had a recently cracked edge which fitted perfectly a corresponding fracture on the Saldanha skull.

The remarkable feature of the mandibular fragment is that it is almost identical in shape and dimensions to the corresponding part of the Mauer jaw (Heidelberg mandible) (Fig. 1). This latter jaw is by far the oldest of the strictly human fossils, and

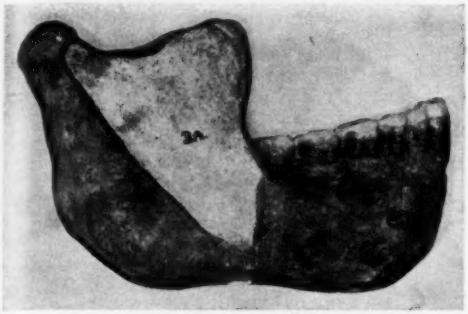

Fig. 1. The Saldanha mandibular fragment (3.4) superimposed on a cast of the Heidelberg mandible

its massiveness and primitive features have kept it for long as an isolated enigma.

There has never been any doubt about the great evolutionary importance of this human prototype, and it is particularly interesting from the South African point of view, where the proportions of the square gibbon-like ramus of this mandible survive in a range of sizes in Bushman, Hottentot and pre-Khoisan jaws. For this reason we have less hesitation in reporting that our evidence, albeit precariously limited, suggests that Saldanha man possessed a counterpart of the Mauer jaw.

While commenting on the large size of the masticatory apparatus of Rhodesian man, the late Sir Arthur Keith[2] pointed out that the width of jaw which this skull required was identical with that supplied by the Mauer jaw; and he might also have added that the huge upper dental arch of the Rhodesian skull requires an even bigger arcade of lower teeth than the Mauer jaw exhibits. There was every likelihood, therefore, that the Rhodesioid Saldanha skull would have a Mauer-like jaw.

Owing to the incompleteness of this ramus, only one of the conventional measurements is available for comparison. This is the important one of the height of the coronoid process above the alveolar plane, the level of which can fortunately be located from the impression on this fossil of the posterior root of the third molar tooth (Fig. 2). This height

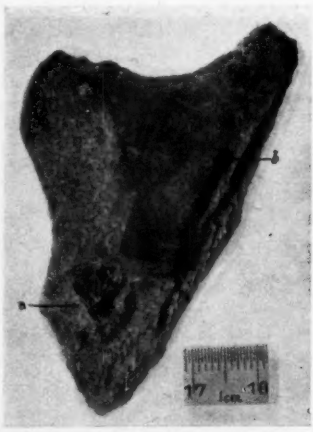

Fig. 2. Lingual aspect of the mandibular fragment, indicating posterior root socket of lower third molar (a), and the position of the mandibular foramen (b)

measurement is 40 mm. in both the Saldanha fragment and the Mauer jaw.

The ramus is fractured diagonally about half a centimetre behind, and parallel to, the inferior dental canal, so that it has been necessary to estimate the width of the ramus. For this, however, good guidance is available from the mandibular foramen, which is shown on the inner side of the specimen (Fig. 2). This opening for the nerve to the lower teeth occupies a fairly constant position relative to the borders of the ramus in jaws of similar type. In our collection of Bushman mandibles, there is an average of 59 per cent of the width of the ramus in front of the opening and 41 per cent behind it, and the same proportions are found in the Mauer jaw. By using these proportions, we estimate the width of the ramus of our specimen to have been approximately 49 mm. This is only 2 mm. less than the width of the Mauer ramus, and this small difference does not materially alter the fact that there is a close typological correspondence between them.

Our fragment is, however, definitely less robust than the corresponding part of the Mauer jaw. This is not unexpected when one considers that, old as both fossils are, the Heidelberg one dates from the beginning and the Saldanha one from towards the end of Chelles-Acheulean (handaxe) times.

The interesting thing is that, while in Europe there is evidence (Swanscombe and Fontéchevade skulls) that man evolved into a sapient type during that long epoch, Saldanha man, on the other hand, has apparently remained typically palæoanthropic in both skull and jaw.

[1] Singer, R., *Amer. J. Phys. Anthrop.*, n.s., **12**, No. 3, 345 (1954).
[2] Keith, A., "The Antiquity of Man", 2, 397 (Williams and Norgate, London, 1929).

DISLOCATIONS, WORK-HARDENING AND CREEP*

By Prof. N. F. MOTT, F.R.S.
Cavendish Laboratory, Cambridge

MY aim in this lecture is to describe in outline the present state of the theory of work-hardening of metals and to propose some new ideas about recovery and creep. What I shall say is based on the theory of dislocations, and indeed is derived very closely from G. I. Taylor's[1] classic paper of 1934. In that paper, Taylor ascribes the resistance to flow or hardness of a metal to the interaction between dislocations; as the metal is deformed, more and more dislocations are formed, so that work-hardening can be ascribed to the increase in this interaction as the strain is increased. At the time that Taylor's paper was written, no model existed to account for the formation of dislocations as a consequence of strain; a model for this purpose was proposed by Frank and Read[2] in 1950 and is now generally accepted, though up to now no direct experimental evidence for its validity has been obtained. The model assumes the presence in an annealed metal of a dislocation network such as that observed in silver bromide by Hedges and Mitchell[3], and shows that each element of the network can act under a low stress as a source of dislocation rings. It thus gives an unforced explanation both of the low

* Substance of a lecture at the Royal Institution delivered on November 2.

yield-stress of annealed crystals and of the localization of slip on a few active slip planes.

The localization of slip on active slip planes makes it difficult to explain work-hardening if one assumes that it is here on the active slip planes that the dislocations are. Slip bands observed under the optical microscope are normally about a micron apart. One can scarcely imagine the material between active slip planes to be free of Frank–Read sources. In a material that has been strained, then, one has to ask why these sources have not generated dislocations. Their interaction with dislocations on the slip lines one micron away would be at least a hundred times too weak to stop them. To solve this dilemma, I suggested[4] that dislocations are formed in the surrounding material, too; I pointed out that in the slip lines we may have to do not only with single dislocations but also with large piled-up groups and that the stress around these groups would be large enough to produce some flow in all parts of the cold-worked crystal.

While some secondary flow of this kind may occur, the observations of Wilsdorf, Van der Merwe and Kuhlmann-Wilsdorf[5] suggest that the solution of the difficulty is more simple; using the electron-microscope and a silica replica, they observe fine slip lines about 200 A. apart, 50 A. high and 10 microns long filling the space between the 'coarse' or visible slip lines or bands. One may assume that these fine slip lines, too, are due to the production of dislocations by Frank–Read sources, and that the dislocations so formed are responsible for hardening the material between the slip bands. Although fine slip may account for as little as ten per cent of the total deformation, it is the dislocations produced by fine slip which must account for the resistance to flow of the weakest part of the material, namely, that between the coarse slip lines. It is the fine slip, therefore, which, according to these ideas, determines the stress-strain curve.

Following and extending the ideas of Wilsdorf and Kuhlmann-Wilsdorf, we may treat the hardening quantitatively as follows: let S and S' in Fig. 1 be two sources which are giving out dislocations at the same time. Let the intersections SX, $S'X'$ of their slip planes with the plane of the paper be at a distance d from one another. Then if the applied stress S is great enough to push a pair of dislocations such as PQ past each other, an arrangement such as that shown in Fig. 1 will result. When the stress is taken off, P and Q will form a doublet and stay together owing to their mutual attraction, as will also P' and Q' and so on. The arrangement is therefore stable. Work-hardening results as d decreases through the formation of more and more fine slip lines, the flow stress S being given according to the authors cited by

$$S = Gb/8\pi(1 - \mu)d$$

Here G is the shear modulus, b the Burgess vector and μ Poisson's ratio. Among the dislocations which result from fine slip we do not envisage anything in the nature of piled-up groups.

Coarse slip may be due to a kind of instability in the mechanism for the formation of fine slip. If one Frank–Read source produces an excess of dislocations which are unpaired with those from any other source, as in Fig. 1(*b*), a piled-up group will form, which could push its way past the dislocations on neighbouring active fine slip planes, so that more and more dislocations are produced from this particular source.

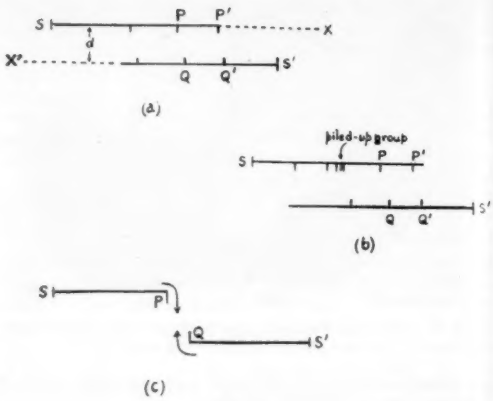

Fig. 1

(*a*) Arrangement of dislocations in fine slip
(*b*) Mechanism for the formation of coarse slip lines
(*c*) Disappearance of dislocations by climb or cross-slip during creep

We have no detailed model for the hardening within a coarse slip band; perhaps the arrangement is similar to that of Fig. 1, but with a longer slip distance and more dislocations. But there are two reasons for believing also that piled-up groups are formed. One is that polycrystalline metals do eventually fracture in a tensile test; as Stroh[6] and I[7] have pointed out, the most natural stress-raiser at which fracture can begin is the piled-up group at the end of a slip line. The other is the broad slip lines observed in fatigue in polycrystalline copper by Wadsworth[8]. An example (at present unpublished) is shown in Fig. 2. The subsidiary slip which occurs here and there at about 45° to the main line looks as though it were due to local stresses around piled-up groups.

Whatever the mechanism of hardening in the coarse slip line, our point remains that if there is no fine slip there should be very little hardening. This prediction seems in fact to be in agreement with observations of the deformation of crystals of alpha-brass. The observations of Wilsdorf[5] for this metal show that there is no fine slip; a model due to

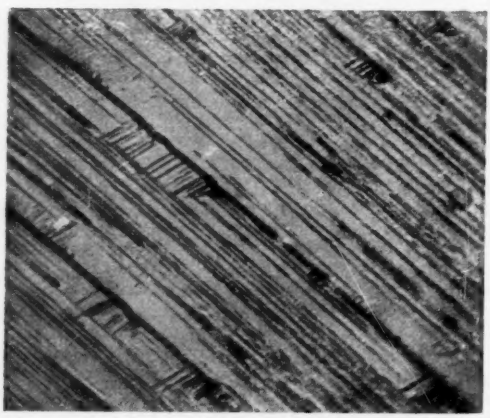

Fig. 2. Microphotographs of slip lines on polycrystalline electrolytic copper after fatigue in push-pull (N. Wadsworth, unpublished). × about 200

Fisher[8] explains this, showing that in solid solutions a source which has once started to generate dislocations has a tendency to continue. But the interesting point about alpha-brass is that, so long as slip is confined to one set of planes, there is very little hardening; coarse slip does not, it seems, harden the intervening material[10].

As shown particularly by Andrade's group[11] and by the work of the Göttingen school[12], work-hardening proceeds more rapidly in single crystals when slip occurs on more than one plane, though the observations relate to the coarse slip only. This we suppose to be due to the mutual locking which, according to the ideas of Cottrell[13] and Lomer[14], can occur when two dislocations in different glide planes interact. This will shorten the slip distance, so that more dislocations will be produced by a given deformation.

Cold-worked materials, as shown, for example, by the experiments of Hirsch and his colleagues[15], show a cellular or polygonized formation, the size of cells being about the same as the distance between the (coarse) slip lines. This seems to us to follow naturally from the model: the material in the cells will be full of pairs of dislocations due to fine slip; but the coarse slip bands, if the amount of slip on a band varies along its length, is bound to lead to a bending of the material between them. This bending gives rise to an excess of dislocations of one sign, and it is these that polygonize and form the walls of the cells.

We turn now to a discussion of creep, and with this model we may ask what is the rate-determining process, in any event in creep under constant stress when the rate of strain has settled down to a constant value. In experiments on pure metals such as those of Wood[16] and of McLean[17], what one observes is the breaking up of the grains into sub-grains. This we believe to be a consequence in polycrystalline material of the bending of the individual grains which must occur[18] during strain and the subsequent polygonization. It is not in our view likely to be the rate-determining process; this will be the plastic deformation of the sub-grains. Further, since the creep under discussion is at a steady rate, and no work-hardening is taking place, the process must be envisaged as shown in Fig. 1 (*c*). Two sources give out dislocations which move into one another's neighbourhood and then annihilate each other. Annihilation can occur by 'climb' in the case of edge dislocations, or by 'cross slip'[19] in the case of screws. It would be of great interest to know whether the dislocations in cold-worked metals are mainly edges or screws. It has frequently been suggested that the dislocation rings given out by Frank–Read sources should be very oblong and mainly of screw type, because of the high stress believed necessary to move a screw dislocation containing jogs. To find out whether this is so, one needs to examine the lengths of the fine slip lines on the top and side surfaces of a strained single crystal; this is a key experiment that ought to be done.

It may be that the annihilation by climb of dislocations such as P and Q can be the rate-determining process in creep. If so, and if the mean distance between jogs along these lines is less than the distance PQ, the activation energy for creep ought to be the same as for self-diffusion and ought not to depend on stress. A recent report by Dorn[20] suggests that this may be so. On the other hand, there is much evidence that, particularly in technical creep-resisting materials, it is slip rather than climb, or self-diffusion, which determines the rate of strain. Materials in solution above the limit of solubility, which slowly diffuse to the dislocations and form atmospheres there in the way proposed by Cottrell[21], are obviously able to impede slip, but scarcely to impede climb. One wonders whether the slow motion of dislocations from points such as S to P is perhaps not the rate-determining process in such metals, their disappearance then always taking place quickly enough to prevent the accumulations of dislocations that we call work-hardening.

If so, it is possible to propose a mechanism for a temperature-dependent movement of dislocations which seems to account for many of the observed facts of creep in pure metals. As mentioned above, the screw elements of dislocation rings are the ones which will find it hard to move, because when they contain jogs they leave behind them a row of vacancies. A screw dislocation can only move forward with the help of temperature if each vacancy produced moves away as soon as it is formed; if it remains *in situ* it will pull the dislocation back. As I have shown[22] in a paper contributed to the recent conference on creep at the National Physical Laboratory, the rate of movement of a screw dislocation under a stress S and at a temperature T might be expressed by a formula of the type:

$$\nu l \exp\{-(W - b^2 l S)/kT\}$$

ν is here an atomic vibrational frequency, l the distance between jogs, and W the energy for self-diffusion. This is the type of formula that many authors (for example, Feltham[23]) use in expressing creep results, with an activation energy that drops sharply with stress. The divergence between these results and those of Dorn, who uses a formula of the type

$$\text{const.} \exp\{-(W/kT) - \beta S\}$$

represents a point of great interest for the theory of creep, though it is difficult to be sure in experiments at different temperatures that l will be the same.

Another point which has been emphasized by Seeger[24] is that the energy of a jog is much greater in copper than aluminium, so that climb will be slower than in the former metal. The rapid recovery of cold-worked aluminium may perhaps be associated with this fact.

[1] Taylor, G. I., *Proc. Roy. Soc.*, A, 145, 362 (1934).
[2] Frank, F. C., and Read, W. T., *Phys. Rev.*, 74, 722 (1950).
[3] Hedges, J. M., and Mitchell, J. W., *Phil. Mag.* (7), 44, 233 (1953).
[4] Mott, N. F., *Phil. Mag.* (7), 43, 1151 (1952).
[5] Kuhlmann-Wilsdorf, D., Van der Merwe, J. H., and Wilsdorf, H., *Phil. Mag.*, 43, 632 (1952); *Acta Metallurgica*, 1, 394 (1953).
[6] Stroh, A. N., *Proc. Roy. Soc.*, A, 223, 404 (1954).
[7] Mott, N. F., *Proc. Roy. Soc.*, A, 220, 1 (1953).
[8] Wadsworth, N. J., and Thompson N., *Phil. Mag.* (7), 45, 223 (1954).
[9] Fisher, J. C., Report to Bristol Conf. Phys. Soc. (1955).
[10] von Göler, F., and Sachs, G., *Z. Phys.*, 55, 581 (1929). Madden, R., Mathewson, C. H., and Hibbard, W. R., *Trans. Amer. Inst. Min. Met. Eng.*, 175, 86 (1948).
[11] Andrade, E. N. da C., and Henderson, C., *Phil. Trans.*, A., 244, 177 (1951).
[12] Lücke, K., and Lange, H., *Z. Metallk.*, 43, 55 (1951).
[13] Cottrell, A. H., *Phil. Mag.* (7), 43, 465 (1952).
[14] Lomer, W. M., *Phil. Mag.* (7), 43, 1327 (1951).
[15] Gay, P., Hirsch, P. B., and Kelly, A., *Acta Cryst.*, 7, 41 (1954).
[16] Gough, H. J., and Wood, W. A., *Proc. Roy. Soc.*, A, 154, 510 (1936); 165, 358 (1938).
[17] McLean, D., *J. Inst. Metals*, 80, 507 (1952); 81, 287 (1953).
[18] Boas, W., and Ogilvie, G. J., *Acta Metallurgica*, 2, 655 (1954).
[19] Mott, N. F., *Proc. Phys. Soc. Lond.*, B, 69, 729 (1951).
[20] Dorn, J. E., Proc. N.P.L. Creep Conf. (H.M.S.O., 1955).
[21] Cottrell, A. H., "Dislocations and Plastic Flow in Crystals" (Oxford, 1951).
[22] Mott, N. F., Proc. N.P.L. Creep Conf. (H.M.S.O., 1955).
[23] Feltham, P., *Nature*, 169, 976 (1952).
[24] Seeger, A., *Z. Naturforsch.*, 9a, 758 (1954).

OBITUARIES

Prof. P. J. Heawood, O.B.E.

Percy John Heawood died in Durham on January 24 in his ninety-fourth year. Educated at Ipswich and at Exeter College, Oxford, he taught mathematics at Durham, first as lecturer and then as professor, for fifty-two years, from 1887 until 1939. His early promise as a mathematician was to some extent thwarted by the width of other interests—religious, intellectual and administrative—which he pursued throughout his academic career at Durham; but he published a paper in his ninetieth year on the four-colour problem, more than sixty years after his first published work on that subject. He held in turn almost every administrative post in Durham, culminating with a two-year term as vice-chancellor in 1926–28. His loyalties were strong, and the strongest was for Durham, where his great memorial will be the Castle, once more standing firm and safe above the River Wear. When it began to slide down the cliff, the University spent all its available resources and despaired of finding the vastly greater sum needed. Almost alone, Heawood would not despair, and as secretary of the Castle Preservation Committee toiled year after year until the newly founded Pilgrim Trust came to the rescue with a very large grant.

Heawood was almost extravagantly unlike other men, in appearance, mannerisms and habits of mind. An immense moustache, an extremely loud voice, and a long cape of strange pattern and manifest antiquity made him conspicuous to eye and ear. He set his watch once a year, on Christmas Day: "No, it's not two hours fast; it's ten hours slow". All his life was organized on equally logical but fantastic lines. Long before he was distinguished by longevity, legends had clustered thick about him. He did not cultivate his reputation as a character. He just went his way and did not care whether people laughed. But this comic side was by no means the whole man. Together with some prejudices and some limitation of sympathies, he was interested up to extreme old age in many sides of the contemporary world, he could be lively and humorous as a speaker, and was an excellent chairman at meetings, for which he had a singular passion. He read Latin, Greek and Hebrew all his life with real appreciation. His transparent sincerity, piety and goodness of heart, and his extraordinary blend of naïveté and shrewdness, secured to him not merely the fascinated interest, but also the respect and indeed the affection, of his colleagues. Latterly he was indeed a Nestor in Durham. He had been teaching there for some years before the oldest member of the present Senate was born.

James Duff

Dr. C. H. Hampshire, C.M.G.

Charles Herbert Hampshire, secretary of the British Pharmacopœia Commission during 1929–50, died in London on January 25 at the age of sixty-nine. He was born at Ilkley, and in 1905 entered the School of the Pharmaceutical Society with a Jacob Bell scholarship and there showed great promise. He gained most of the prize medals of his year, qualified as a pharmacist and later joined the staff and took a London honours degree in chemistry. An early intention to follow a career in teaching was abandoned in 1914 when he was appointed chief pharmacist at University College Hospital, London, a post which he held until 1929. During this period he became a student in medicine, not with the intention of taking up medical practice but in order to fit himself for the expanding responsibilities of the pharmaceutical department of a teaching hospital. He obtained the Conjoint diploma in 1925 and the M.B., B.S. of London in 1927.

These earlier phases of Dr. Hampshire's career proved their value when, in 1929, he was appointed secretary of the British Pharmacopœia Commission, a body newly created by the General Medical Council on the advice of the Macmillan sub-committee of the Committee of Civil Research. He developed the permanent organization to serve the work of succeeding Commissions in the evolution of a modern pharmacopœia, and his twenty-one years of office saw the "British Pharmacopœia" achieve a standard which is respected throughout the world. He was responsible for a new edition in 1932 and, after the issue of six war-time "Addenda", he dealt with another edition in 1948. To this complicated work he brought unstinted energy and wide knowledge.

Early in his career Dr. Hampshire became interested in the development of an international pharmacopœia and in 1937 was appointed chairman of the Technical Committee of Pharmacopœial Experts set up by the League of Nations; after the War he was called upon to preside over the Expert Committee on the Unification of Pharmacopœias appointed by the World Health Organization. In 1951 he was able to present the first volume of the "Pharmacopœa Internationalis" to the assembly of the Fédération Internationale Pharmaceutique in Rome, and to the end of his life he continued his work on the preparation of further volumes.

He will be remembered chiefly for his major achievements as a pharmacopœial expert, but he gave long and devoted service to other aspects of pharmacy and medicine. He was editor of the *Quarterly Journal of Pharmacy and Pharmacology* from 1928 and continued in office when it became a monthly publication in 1949. He was chairman of the British Pharmaceutical Conference during 1932–34, and for many years a member of the board of examiners of the Pharmaceutical Society and of the Royal Institute of Chemistry, of which he was a Fellow. In 1949 he was made a Companion of the Order of St. Michael and St. George. By Dr. Hampshire's death international pharmacy has been deprived of one of its most distinguished figures, and British pharmacy has lost a dignified and devoted servant.

T. C. Denston

Lord Charnwood

Lord Charnwood, who died on February 1 at the early age of fifty-three, and who made some notable contributions to the study of physiological optics, and particularly binocular vision, was the son of the first Baron Charnwood and Dorothea May Roby. A product of Eton and Balliol, he later trained as a mechanical engineer, becoming the chief engineer of Bamford-Martin, the original makers of the Aston-Martin car. During the War he became interested in problems connected with the training of range-takers, using stereoscopic range finders. This gave him his first opportunity of carrying out experimental work on vision. Eventually he qualified as an ophthalmic optician, becoming a Fellow of the

British Optical Association, and afterwards an Honours Fellow of the Worshipful Company of Spectacle Makers.

He practised in London and joined the staff of the London Refraction Hospital, where much of his research work was carried out. Lord Charnwood was the first recipient of the new higher diploma of the Worshipful Company of Spectacle Makers, and was awarded the Master's prize for his thesis on binocular vision. He was awarded an honorary diploma in orthoptics by the British Optical Association in 1952, and the Research Medal of that body in 1954.

He was also a lay Fellow of the Royal Society of Medicine, a Fellow of the Physical Society, and of the Royal Microscopical Society. He was a Fellow of the American Academy of Optometry, and had lectured widely in the United States. His output during these eight years was outstanding, as the following will show.

Lord Charnwood described his research as a "record of unrelated small attacks on a number of facets of the problem of how the brain contrives to drive the two eyes in double harness". His most important work was probably his "Essay on Binocular Vision", published in 1950; but his paper on "Retinal Slip", read at the International Optical Congress in 1951, and reported in the *Transactions*, was of an equally high standard. Other work carried out by him was described in a number of contributions between 1947 and 1952. These included "Some Anomalies of Binocular Vision", a paper read at the London Refraction Hospital Congress, 1947, and "Notes on Prolonged Occlusion" (*Optician*, August 8, 1947), following Marlow's work on this subject. This was afterwards extended to include the treatment value of occlusion in binocular imbalance, described in a paper, "The Diagnostic and Therapeutic Use of Monocular Occlusion" (*Brit. J. Physiol. Optics*, January 1951), and a number of papers in *The Optician*, including one on the "Mathematical Analysis of Binocular Vision" (Jan. 30, 1948).

An interesting and unusual contribution was his "Influence of Alcohol on Fusion" (*Brit. J. Ophthalmology*, 1950), in which he demonstrated the reduction of the fusional reserves under the imbibition of alcohol, and suggested that some comparable intoxication might be the means whereby such illnesses as measles and whooping cough precipitate squints. He had a communication in *Nature* of August 26, 1950, on the "Effect of Posture on Involuntary Eye Movements".

Lord Charnwood's final contributions, "Stereopsis in the Presence of Diplopia" and "Fusion in Binocular Vision", a criticism of Asher's suppression theory, were both produced in 1954 and published in the *British Journal of Physiological Optics* a few months before he died.

By his death, the optical profession has lost an outstanding figure, and he leaves behind him many friends.

G. H. GILES

NEWS and VIEWS

Zoology at Bedford College, London: Prof. N. Millott

PROF. NORMAN MILLOTT, who succeeds Prof. H. Munro Fox in the chair of zoology at Bedford College, University of London (see *Nature*, **174**, 537; 1954), is a graduate of the University of Sheffield. His early work, on the morphology and physiology of the gastropod mollusc *Jorunna*, completed during the period of his first university appointment as demonstrator in the University of Manchester, was accepted for publication by the Royal Society and its excellence recognized by the award, in 1936, of the Rouse Ball Studentship at Trinity College, Cambridge. Under the influence of the Cambridge experimental school, Prof. Millott began his investigations of the form and properties of the visceral nervous system of the earthworm *Lumbricus* and of the nervous control of secretion, the results of which were published in a series of papers in the *Proceedings of the Royal Society*. During the War, Prof. Millott served as a signals officer in the Royal Air Force and on demobilization returned to Manchester, first as a lecturer and later as a reader in zoology. When in 1947 applications were invited for the chair of zoology in the newly founded University College of the West Indies, Prof. Millott, now well known as a stimulating teacher and for the originality and high quality of his research work, was selected for the important task of organizing the Department of Zoology, and, in consultation with the University of London, of devising courses suitable for overseas students taking the B.Sc. degree of London. In this he has been conspicuously successful. During his eight years in the West Indies, Prof. Millott has, moreover, not only maintained his contacts with British universities but also has spent much of his vacation time visiting and working in American universities and laboratories. His experience and qualities will ensure him a warm welcome from his future colleagues in Bedford College and from fellow zoologists throughout the University of London.

James Clayton Prize for 1954: Sir Christopher Hinton, F.R.S.

THE James Clayton Prize for 1954 of the Institution of Mechanical Engineers has been awarded to Sir Christopher Hinton for his pioneer work in applying the results of nuclear research to the production of fissile material and industrial power, communicated in part in a lecture delivered to the Institution of Mechanical Engineers during 1954. By the terms of the will of the late Mr. James Clayton, not less than one-quarter of the annual income accruing from the James Clayton Trust Fund shall be awarded as a prize to a member, associate member, graduate or student of the Institution for a contribution during the year to modern mechanical engineering science by way of research, invention or experimental work, or by a treatise or paper on a modern mechanical engineering subject; or by originality in design; or by service to mechanical engineering. The sum of £1,620 was available for the 1954 award.

Expenditure by the Department of Scientific and Industrial Research

REPLYING in the House of Commons to questions regarding grants to research associations, Mr. J. R. Bevins, Parliamentary Secretary to the Ministry of Works, as representing the Lord President of the

Council, stated on January 28 that about £40,000 of the additional £91,000 allocated to research associations by the Department of Scientific and Industrial Research during the present financial year is for providing increased grants for a number of existing associations and initial grants to the Chalk, Lime and Allied Industries Research Association, the British Steel Castings Research Association and the Timber Development Research Council. The remainder is for capital grants to the Electrical Research Association and the Production Engineering Research Association. On February 1, Mr. Bevins added that in the financial year 1950–51 capital grants of £271,000 were made to research associations; in 1951–52, £53,000; in 1952–53, £17,000; in 1953–54, £2,000. It was expected to make no capital payments in the present financial year. Industries were asked to undertake to raise special contributions over and above their normal revenue contributions to the research associations, and the estimates of the total cost have to be submitted to the Department of Scientific and Industrial Research for approval. He also referred to the special surveys of the resources, facilities and programmes of the leather, cast iron and ceramics research associations, which were carried out as an experiment in 1950–51; a survey of the work of the British Scientific Instrument Research Association has just been started.

The affairs of the Department of Scientific and Industrial Research were again the subject of questions in the House of Commons on February 8. Mr. Bevins stated then that only about five per cent of the Department's work is directly undertaken for defence, and that is normally paid for by the Defence Department. In a written answer, he said that the staff establishment at the Fuel Research Station in 1953–54 was 292 and the expenditure £268,535, compared with 311 and £295,550, respectively, in 1954–55. Asked for an estimate of the expenditure of the Department in terms of 1946 values, he gave the following figures for gross expenditure based on the price index for all consumer goods and services calculated by the Central Statistical Office annually.

1944–45	£1,491,000	1949–50	£3,662,000
1945–46	1,685,000	1950–51	4,019,000
1946–47	2,208,000	1951–52	4,035,000
1947–48	2,825,000	1952–53	4,085,000
1948–49	3,198,000	1953–54	4,076,000

Referring to the Geological Survey, he said that about 60 per cent of England and Wales, 90 per cent of Scotland and all Northern Ireland have been surveyed in detail, but he could not state when the survey would be completed.

Earth Tremors in Quetta

A swarm of strong earth tremors, about forty in number, starting about February 13 and continuing on February 20, has affected the district around Quetta. Damage to the water supply system and a temporary breakdown of electricity supplies and telephone communications are reported; and there has been damage to property, with some fatal casualties. There is some apprehension in the district, since many remember the earthquakes of May 1935 when some twenty-five thousand people were killed.

Journal of the West African Science Association

Before the Second World War, some excellent scientific work was done in the British West African territories; but the number of research workers was small, they were mostly in government service with much of their time taken up in routine work, and there was little difficulty in finding an outlet for the publication of results in the existing journals. Since the War, the establishment of the new University Colleges in the Gold Coast and in Nigeria, and the development and expansion of the independent research institutes dealing with trypanosomiasis, virus diseases, cocoa, oil palms, fisheries, etc., has greatly increased the volume of original work, at a time when existing journals are crowded and publication of new work is often long delayed. A new publication, the *Journal of the West African Science Association* (1, Part 1; October 1954. Pp. 72+ 1 plate. London: Charles Knight and Co., Ltd. 21*s*. per vol. (2 parts)), is intended to serve as an outlet for work dealing with West Africa as a whole. It is well produced (printed in England), and the papers in the first number reach the standard required by most established journals. They cover a wide field—the geography of Nigeria's coastline, the geology of the Achimota College cricket field, land utilization, check lists of molluscs and seaweeds, new records of flowering plants, and a review of recent work on soil fertility. It is stated that one reason for producing this new journal is that "it is convenient for research workers to have their papers on this area readily available within one journal". This can only be true to a limited extent. If reviews of interest to scientific workers generally are to form the journal's main contents that will be true, and the paper on soil fertility (by P. H. Nye) fulfils this object; but the other papers are more specialized, and it is difficult to imagine that many members of the West African Science Association will read more than one or two with interest or understanding. Research as a whole is bound to be specialized, however much this may be deprecated, and by trying to cover too wide a field this journal might defeat its object. However, West Africa is developing rapidly and there is certainly room for this and more journals like it; it is probable that as it grows it will be necessary to divide it into various sections dealing with different subjects, and perhaps later on it will become the parent of a distinguished family of scientific publications.

Bulletin of the Research Council of Israel

The Israel Research Council was set up some years ago to organize and stimulate research in all branches of science and technology and to co-ordinate the work of the many scientific institutes in the country. The *Bulletin of the Research Council of Israel* is published quarterly (Jerusalem: Israel Scientific Press. Annual subscription, I£4.000, 5.50 dollars) and contains original papers as well as preliminary communications in the form of "Letters to the Editor". Papers are submitted in English or French, and summaries of them are collected together at the back of each issue, where they can be easily consulted. Volume 4, No. 1 (June 1954) contains nineteen papers, of which several are on biochemical or chemical topics. Three of these papers are contributions from American laboratories and the rest are from workers in the Hebrew University, the Israel Institute of Technology, the Weizmann Institute or other laboratories in Israel. L. Picard, of the Israel Geological Institute, has written an interesting article on the structural pattern of Palestine, and there are two papers of technological interest as well as others on botanical

and zoological subjects. The standard of the articles appears to be high, and the journal itself is well produced. A whole section of this issue of the *Bulletin* reports the proceedings of the Israel Chemical Society by giving adequate abstracts of the communications in inorganic, organic and physical chemistry which were delivered. There is also a biographical sketch of Prof. Andor Fodor, on the occasion of his seventieth birthday, to commemorate his long association with the Hebrew University and with the development of scientific work in Israel.

Research Essay Competition

THE Scientific Advisory Board of *Research* has decided for the third successive year to organize a "Science in Industry" essay competition. The purpose of the competition is to encourage scientists to take greater interest in the problem of presenting the results of scientific research work to people less highly qualified than themselves. It will be in two parts. The first part aims at directing attention to the problem of the scientist in communicating with the industrial policy-maker. Often, the board of directors of an industrial firm contains no member with scientific or technical training. Scientists must learn how to put forward the case for the development or investigation of some new scientific process or project in terms which a technically unqualified board can appreciate. Competitors are required to make their case in an essay of about three thousand words in length. Prizes amounting to £200 are to be awarded for this part of the competition. In addition, the author of the best essay will receive a special new award to be known as the Waverley Gold Medal. The second part of the competition requires the scientist to discuss one of four set subjects in a manner suitable for publication in a general newspaper. The prizes for this part of the competition, amounting to £150, are to be awarded by the *Sunday Times*. Further information can be obtained from the offices of *Research*, 88 Kingsway, London, W.C.2.

Endeavour

MAINTAINING its standard of excellence, the latest number of the journal *Endeavour* (issued by Imperial Chemical Industries, Ltd.) contains some interesting and important articles. Sir Macfarlane Burnet, for example, examines the riddle of the influenza virus and shows that growing knowledge of the influenza virus leads to the conclusion that, while this has distinct antigenic, enzymic and genetic properties, it is at the same time chemically indistinguishable from fragments of the cytoplasm of the cells in which it is a parasite; this conclusion is of fundamental importance, not only in devising new methods of attacking what can be a very deadly disease but also for understanding the structure and function of the vertebrate cell. Dr. Charles Singer describes some of Robert Hooke's brilliant contributions to biology, and Dr. E. N. Willmer discusses the sensation which human beings call "white". "Storms in the Ionosphere" is the subject of an article by Sir Edward Appleton, while the place of James Muspratt and his family in the British heavy chemical industry is considered by Dr. D. W. F. Hardie. Dr. A. Frey-Wyssling describes some information collected by the use of the electron microscope in plant cytology, and Prof. Munro Fox surveys the principal types of coloration in animals and is supported by some colour photographs which have been faultlessly reproduced.

Research in the Social Sciences

THE National Institute of Economic and Social Research has again published its Register of Research in the Social Sciences. This follows the plan of the ten previous numbers, although two substantial changes have been made. The first has been to cut down drastically the amount of repetition of information that has already been recorded in previous issues. This will mean that, for fuller information about research items that have already been reported in a previous Register, the user must consult that issue; the reference back is given in each case. New information about work in progress or work newly completed has been included. The second change has been to revise the section of the classification dealing with economics. The new classification replaces one that had become progressively less suitable as a means of classifying contemporary research in Great Britain. The year 1953–54 shows a substantial increase in the number of new research projects that have been reported, the total having risen from 201 in 1952–53 to 291 in the current Register. This increase is largely the consequence of the impact of the Conditional Aid economic and social research programmes in Great Britain. These new programmes, supported by funds derived from the United States, have provided finance for about sixty of the new inquiries reported here. The programmes are designed to encourage and expand research of all kinds into factors affecting the efficiency of the national economy. Thus nearly half the economic research recorded here into business structure and functioning, monopoly and competition, productivity and efficiency, is supported by Conditional Aid; it also provides funds for a quarter of the work in industrial relations and management.

City of Manchester Public Libraries: Report for the Year 1953–54

THE hundred and second report of the City of Manchester Public Libraries Committee (pp. 16+28+35+4 plates; Manchester Public Libraries, 1954) covers the year ended March 31, 1954, but records the death of the City Librarian, Mr. Charles Nowell, on August 9, 1954, while the report was in preparation. Although the reference libraries continued to attract more readers—627,847 in place of 602,528 the previous year, with an increase in the issue of books from 719,361 to 769,917—fewer books were borrowed from the lending libraries, and the total number of volumes issued to readers decreased from 6,241,375 to 5,929,621. The addition of 102,115 volumes brought the total stock to 1,095,333, of which 663,074 are available for loan. A census of users of the central library during 9 a.m.–9 p.m. was made on March 30, 1954, and the results are detailed in a summary accompanying, like the usual statistical summary, the annual report. Of 4,156 entering the library, 3,080 completed the census form as requested: of 689 users of the reference library, 237 lived in Manchester and 452 elsewhere; in the commercial library there were 192 Manchester residents to 305 outside the City boundary; in the technical library the proportion was 123 to 170; and in the central lending library, as might be expected, there were 816 Manchester residents to 314 non-residents. Of those visiting the periodicals room, 143 were Manchester residents and 120 from outside the City boundary; for the Henry Watson music library the

corresponding figures were seventy-two and eighty-five, respectively, while eight readers visiting the special collections were non-residents of Manchester and three residents. Following the publication of the Manchester Joint Research Council's survey, "Science and Industry", the 225 firms participating in the survey were circularized with a brief statement of the services offered by the technical library, which now holds 86,572 volumes, and a selection of the latest publications. A large proportion of the inquiries received were connected with technical research or development. The number of readers using the library increased by 4,812 to 150,388, and the number of periodicals consulted increased, although the number of books used decreased slightly. Stress is laid on the importance of co-operation in this field and on the cost of scientific and technical books, which during the year averaged 40*s*. 8*d*. per volume.

Nitrogen Metabolism of Groundnut Plants

L. Fowden (*Ann. Bot.*, **18**, 72, 417; 1954), in an investigation of the nitrogen metabolism of *Arachis hypogaea*, has considered in some detail the role of γ-methyleneglutamine and γ-methyleneglutamic acid —two new compounds which are apparently not widely distributed in plants, as are, for example, asparagine and glutamine. The evidence that γ-methyleneglutamine was not present in ungerminated groundnut seeds and that γ-methyleneglutamic acid could not be detected in an acid hydrolysate of arachin, the principal reserve protein of groundnut seeds, suggested the possibility that important differences may be encountered between the roles of the new amide in groundnut plants and those of asparagine and glutamine in other species. The changes in various nitrogenous fractions during the growth of groundnut seedlings in the dark were compared with those occurring in seedlings grown in the light. The distribution of amides and acidic amino-acids in the various organs of young and mature plants has also been studied quantitatively, and observations have been made upon the amino-acids present in developing fruits. The author discusses the possible pathways of synthesis and the functions of these two substances in the groundnut plant.

Rayleigh Waves in a Medium with Two Surface Layers

The problem of the propagation of waves of Rayleigh type in a uniform semi-infinite elastic medium with two uniform surface layers has been solved by R. Stoneley, in a paper entitled "Rayleigh Waves in a Medium with Two Surface Layers" (*Mon. Not. Roy. Astro. Soc.*, Geophys. Supp., **6**, No. 9, 610; 1954). The waves are dispersive, and the wave velocity equation turns out to be a determinant of the tenth order. Various tests on the equation proved it to be satisfactory: for example, by making infinite the thickness of the surface sheet it is possible to derive the velocity equation for waves in an internal stratum; and by making the thickness of either sheet zero, the known equation for the velocity of Rayleigh waves in a medium with a single surface layer is obtained. If the wave-length is very small, the determinant reduces to the product of three determinants, which, equated in turn to zero, are the velocity equations of very short Rayleigh waves at the free surface and of very short waves of Rayleigh type at the two interfaces. Dr. Stoneley intends to give the results of a numerical solution of the wave equation at a later date, as well as a discussion of the application of the results to the actual surface waves of earthquakes.

"The Rationalist Annual"

Among the articles contributed to "The Rationalist Annual" for 1955 (pp. 81. London: C. A. Watts and Co., Ltd., 1954. Cloth, 5*s*.; paper, 2*s*. 6*d*.) are the late Sir Arthur Keith's comparison of Darwin and Locke as philosophers, "Darwin's Place among Philosophers". Sir Arthur claimed that if Locke is accepted as a philosopher, Darwin must be regarded as one too, and he added that Darwin was the only philosopher known to him who could help in the interpretation of the problems of nationality and war which vex our modern world. Mrs. Margaret Knight suggests that good and evil, and joy and pain, are reconciled, in the only sense in which their reconciliation is possible, on the æsthetic plane; but her essay seems to touch the experience of the scientist, as such, less than those of Prof. Morris Ginsberg on "Durkheim's Theory of Religion" and Prof. J. B. S. Haldane on "The Origin of Purpose". Prof. V. Gordon Childe writes briefly on "The Stone Age comes to Life", E. H. Hutton on "Religion and the Physicists", Antony Flew on "The Third Maxim", an analysis of the reason J. B. S. Haldane once gave for not being a materialist, Bertram Joseph on "The Renaissance Mind" and Ernest Gellner "On Being Wrong".

Microwave and Radio-frequency Spectroscopy

The Faraday Society will hold a General Discussion on "Microwave and Radio-frequency Spectroscopy" in the Department of Zoology, University of Cambridge, during April 4–6. The programme will be in four parts, at each of which a general introduction will be given by the person shown: microwave spectroscopy (Prof. H. C. Longuet-Higgins, University of Cambridge); microwave absorption (Dr. T. M. Sugden, University of Cambridge); nuclear magnetic resonance (Prof. H. S. Gutowsky, University of Illinois); and quadrupole spectroscopy (Prof. B. P. Dailey, Columbia University). Twenty-three papers will be read, and advance proofs will be circulated about the middle of March. Applications for accommodation must be made by March 23. Further information can be obtained from the Secretary, Faraday Society, 6 Gray's Inn Square, Gray's Inn, London, W.C.1.

Summer School of Welding

The fifth Summer School of Welding organized by the British Welding Research Association will be held at Ashorne Hill, near Leamington Spa, Warwickshire, during June 27–July 2. The School will take for its basic theme "Welding Developments in British Industry", and has been devised to cover various aspects in logical sequence during the course. As in previous years, lectures of general interest will be given in the morning, and lectures of more specialized interest in the afternoon. To meet particular requirements, the course will be divided into the following groups: *A*, pressure vessels; *B*, transport; *C*, shipbuilding; *D*, specialized welding techniques. It is possible that an additional group on "Inspection and Testing" will also be included. Further information can be obtained from the Organizing Secretary, Summer School of Welding, B.W.R.A., 29 Park Crescent, London, W.1.

The Night Sky in March

FULL moon occurs on March 8d. 15h. 41m., U.T., and new moon on March 24d. 03h. 42m. The following conjunctions with the moon take place: March 4d. 10h., Jupiter 2° N.; March 13d. 22h., Saturn 6° N.; March 21d. 02h., Venus 4° S.; March 22d. 11h., Mercury 7° S.; March 27d. 11h., Mars 3° S.; March 31d. 16h., Jupiter 2° N. Mercury rises a little before 6h. up to the middle of the month, and about 5h. 30m. at the end of the month—only a quarter of an hour before sunrise—and is unfavourably placed for observation during the whole of March. Venus rises about 5h. up to the middle of the month, and an hour before sunrise on March 31. It will be conspicuous in the eastern sky and will become more easily observed in the northern hemisphere owing to its increasing northerly declination; the visible portion of its illuminated disk increases from 0·651 to 0·753, and its stellar magnitude varies from −3·7 to −3·5 between March 1 and 31. Mars rises at 22h. 30m. during the month; its eastward movement in Aries brings it close to 3 Arietis about March 26, and during the month its stellar magnitude varies from 1·4 to 1·7, largely owing to its distance from the earth increasing from 176 to 197 million miles. Jupiter, visible throughout the night and early morning hours, sets at 5h., 4h. and 3h. on March 1, 15 and 31, respectively; its decrease in brightness from magnitude −2 to −1·8 is due to its distance from the earth increasing from 424 to 464 million miles during the month. Saturn rises at 0h. 10m., 23h. 10m. and 22h. 05m. on March 1, 15 and 31, respectively, and lies rather low in Libra, stellar magnitude 0·6–0·5, the small increase in brightness resulting from its distance from the earth decreasing from 886 to 848 million miles. Occultations of stars brighter than magnitude 6 are as follows, observations being made at Greenwich: March 1d. 22h. 02·6m., 99 Tau. (*D*); March 2d. 23h. 59·7m., 1 Gem. (*D*); March 10d. 21h. 33·5m., 370*B*, Vir. (*R*); March 28d. 19h. 09·6m., 284*B*, Tau. (*D*); March 28d. 21h. 53·4m., τ Tau. (*D*); March 31d. 22h. 49·7m., *g* Gem. (*D*), where *D* and *R* refer to disappearance and reappearance, respectively. Vernal equinox occurs on March 21d. 10h.

Announcements

DR. H. G. TAYLOR, director of research of the British Welding Research Association since 1947, has been elected president of the Society of Engineers.

DR. GERHARD HERZBERG, director of the Division of Physics of the National Research Council of Canada, has been elected an Honorary Fellow of the Indian Academy of Sciences "in recognition of his scientific eminence and of his outstanding contributions to knowledge".

THE second Marjory Stephenson Memorial Lecture arranged by the Society for General Microbiology will be given by Prof. C. B. Van Niel, of the Hopkins Marine Biological Station, Pacific Grove, California, at the Royal Institution, Albemarle Street, London, on April 18, at 6 p.m. He will speak on "Natural Selection in the Microbial World". The Lecture is open to the public.

THE U.S. Administration has asked the National Academy of Sciences to appoint a committee to advise on the formulation of Federal Government policy dealing with the relations between questions of loyalty and the awarding of grants and contracts in support of unclassified scientific research.

DR. F. W. G. WHITE, C.B.E., chief executive officer of the Commonwealth Scientific and Industrial Research Organization, Australia, has been invited by the Government of Egypt to advise it on the organization of scientific research in Egypt. Dr. White will visit Egypt under the ægis of the Unesco Technical Assistance Programme for Egypt.

SINCE the Princess Alice appeal for a million pounds for the University College of the West Indies was made on January 15, more than £400,000 has been offered in the form of donations and covenants (see also *Nature* of February 19, p. 328). The money is to be used for the establishment and endowment of teaching and research scholarships, bursaries, etc., a chapel and for general purposes.

A CONFERENCE to commemorate the jubilee of the announcement by Albert Einstein in 1905 of the theory of relativity will be held this summer at Berne under the presidency of Prof. W. Pauli (Zurich). Prof. A. Mercier (Institute of Theoretical Physics, University of Berne) will act as secretary for the conference. Several authorities on cosmology, unified field theories, etc., have been invited to give addresses or take part in the scientific discussions.

THE Universities Federation for Animal Welfare will hold its Easter congress in St. Patrick's Hall, University of Reading, during April 1–4. The fee for the congress, which includes full board and all expeditions, is 3 guineas (students 30*s*.). Applications should be addressed to Miss M. P. Williams, UFAW, 7*a* Lamb's Conduit Passage, London, W.C.1, from whom further information can be obtained.

THE Ministry of Agriculture and Fisheries and the Department of Agriculture for Scotland propose to award, for the academic year beginning on October 1, a limited number of postgraduate scholarships in agricultural economics, husbandry, statistics and agricultural and dairy engineering. The closing date for applications is March 31. Further information can be obtained from the Secretary, Ministry of Agriculture and Fisheries (Research Branch), 1–4 Cambridge Terrace, Regent's Park, London, N.W.1, or the Secretary, Department of Agriculture for Scotland, St. Andrew's House, Edinburgh 1.

A SUB-SECTION of the University and Research Section of the Library Association has been formed, the object of which is to foster the formation, growth and usefulness of libraries in colleges of technology and further education. The committee consists of the following: *Chairman*, L. L. Ardern (Manchester College of Technology); *Vice-Chairman*, E. G. Baxter (Coventry Technical College); *Honorary Secretary*, G. H. Wright (Westminster Technical College); *Honorary Treasurer*, E. R. Yescombe (Northern Polytechnic, London); *Members*, F. C. Adey (Leicester Colleges of Art and Technology), O. M. V. Argles (Hatfield Technical College), J. Fry (Cardiff Technical College) and E. R. McColvin (Regent Street Polytechnic, London). Further information can be obtained from the honorary secretary, Gordon H. Wright, Greenway Court, Hollingbourne, Kent.

A MEMORIAL service for the late Sir Edward Mellanby will be held at the church of St. Martin-in-the-Fields, London, at 11.30 a.m. on March 17.

THE NUFFIELD FOUNDATION

ANNUAL REPORT

THE ninth report of the Nuffield Foundation* covers the year ended March 31, 1954, when the Foundation's second five-year programme terminated, in which allocations totalling £594,302 brought the total of grants during the quinquennium to more than £3 million, and that since the Foundation was established in 1943 to more than £5 million. Grants in the United Kingdom during the year included £18,938 from the Foundation's uncommitted resources, or 'free fund', £104,450 for biological studies and £120,445 for sociological studies. £189,428 was allocated for research in the Commonwealth overseas, £46,400 for research into practical problems, £51,080 for the care of old people, £46,178 for miscellaneous projects and £27,226 for the continuation of its past programme, while a further £10,000 was allocated to the Oliver Bird Fund.

Reviewing first, however, the past quinquennium as a whole, the report notes that of £3,031,526 allocated in 1949–54, £441,897 was for biological and £376,188 for other scientific studies and £416,555 for social research in the United Kingdom. £396,080 was for the care of old people and £146,070 for research on rheumatism, while the programme of training and travelling fellowships and similar awards received £515,056. During the quinquennium, while continuing its provision of scholarships designed to encourage travel for study within the Commonwealth, the Foundation has thought it opportune to extend help for research to institutions and people in overseas parts of the Commonwealth, where private-adventure money is more keenly needed, sought and valued. The latest allocation has been one of £250,000 for certain university colleges in the Colonial territories, and the Foundation hopes that on an expanding scale it may devote its attention to overseas parts of the Commonwealth, where growth is still young and vigorous and experiment is necessarily the order of the day.

Another innovation during the quinquennium has been the decision, in the light of an investigation into hospital functions and design, to establish for ten years a division for architectural studies as part of the Foundation's headquarters organization. The immediate programme of the new division includes the study of children's hospitals, research laboratories and farm buildings.

During the coming five years, the Foundation hopes to make its major contribution to the support of research in the United Kingdom in science, medicine and technology. In science its present preference and programme for biology will continue but on a reduced scale; and within the natural sciences the Foundation will be watchful for opportunities of encouraging those workers capable of devising the new concepts, tools or techniques from which unpredictable, but invaluable, advances may ensue. In medicine, the Foundation intends to build up further two or three existing centres of research on the chronic rheumatic diseases and will maintain a special interest in investigations into the causes of those mental and physical defects which throw so heavy a burden on the family and the community. In technology, besides agriculture, architecture, food and domestic science, the application of science to industry and fundamental applied science, the Foundation is ready to retain an interest in the shortage of scientists and able persons generally, and particularly in the shortage of science teachers in schools.

In the social sciences, the Foundation will be concerned to encourage fundamental research as well as studies of major social developments effected by legislation or similar means, urban studies, further work on social mobility and the problem of local government. Besides encouraging the collection and collation of facts about old people, the Foundation will be ready to assist research in the employment of elderly workers and into the process of ageing. All the current fellowship schemes are being continued; but some will be replaced during the quinquennium by new and experimental schemes.

Both new grants from the Foundation's 'free fund' during the year are in the medical field: £6,000 for accommodation for a gastro-enterological research centre at the Central Middlesex Hospital, and £2,500 to the Department of Surgery at the Postgraduate Medical School of London for the construction of a second and improved heart–lung machine. An additional £5,000 has been allocated to the Mathematical Laboratory, University of Cambridge, for the construction of an electronic calculating machine and a further £5,000 reserved for another year.

In the biological sciences, grants were made for twelve new projects and for ten additional or renewed projects. New grants include £12,000 over four years to the Department of Botany, The Queen's University, Belfast, for quaternary ecological studies; £10,000 over five years to the Botanical Society of the British Isles towards the preparation of a distribution atlas of British flowering plants, and £10,000 to the Cavendish Laboratory, University of Cambridge, for the purchase of an electron microscope of high resolving power; £4,300 over two years for work on population genetics at the Department of Social and Preventive Medicine, The Queen's University, Belfast; £3,200 over four years to the Department of Zoology, University of Edinburgh, for special equipment and technical assistance in work on developmental energetics; and £2,500 a year for three years for additional research assistance and materials for the work on vitamin A and the metabolism of sterols in the Department of Biochemistry, University of Liverpool. An additional £1,500 has been contributed to the biophysical work at the Wheatstone Physics Laboratory, King's College, University of London, £2,400 over three years for research at University College, London, on electrical changes in central nervous tissues, a further £7,950 over three years for the investigation at University College, London, into proliferation and morphogenesis in the adult, and a renewed tapering contribution of £2,400 a year for the first three years and £1,200 a year for the last two years for the work on cell biology at the Strangeways Research Laboratory, Cambridge. Further sums of £2,000 a year for equipment and materials and £650 a year for two years for an additional assistant physicist have been

* Nuffield Foundation. Report for the year ended 31 March 1954. Pp. 141. (London: Nuffield Foundation, 1954.)

offered to the Department of Physics Applied to Medicine, Middlesex Hospital Medical School, for the study of the mineral activity of adrenal steroids.

Six of the twelve grants made for sociological studies during the year were new. One of those, of £4,500 over two years, is for an inquiry being conducted by the Institute of Community Studies, London, into various aspects of ageing in relation to family life and care within the family. Another, of £3,000 a year for three years, is to the Institute of Education, University of London, for an inquiry into the social characteristics of the teaching profession, including the changing geographical and social sources of recruitment to the teaching profession in England and Wales, and the relation of its origins to characteristic features of its way of life. A grant of £3,000 over two years has also been made to the Royal Institute of Public Administration for an inquiry into alternative sources of local revenue the results of which should greatly assist in deciding upon the character of the local government reforms required in Britain. Two grants have been made to the Institute of Social Anthropology, University of Oxford: one of £1,000 for a study in Cyprus and the other of £1,500 over three and a half years for a structural analysis of the State of Israel, with special regard to its position as a Middle Eastern nation.

Renewed or additional grants in this field include £3,600 over three years for research of the 'operational' type at the Department of Social Science, University of Liverpool, for the continuation of studies on community and race-relations. A grant of £10,000, tapering from £3,600 in the first year to £400 in the fifth, has been offered to the Division of Research Techniques, London School of Economics and Political Science, for current field-research on methods of reducing the cost of random sampling, the variability between interviewers, the design of questionnaires and social classifications and their use in sampling inquiries. £8,000 goes to the Institute of Statistics, University of Oxford, for a third national survey of income and savings and a further £2,500 over two years to the Department of Psychology, University of Reading, for continuing its work on visual aids to learning. A renewed grant of £2,000 a year for two years to the Department of Town Planning, University College, London, will enable the main results so far reached in case-studies of three local planning authorities to be tested against comparable material from other authorities.

Of two new grants from the Oliver Bird Fund made during the year, one of £20,000 (since increased to £27,000) is to provide and furnish a new building for the Rheumatic Unit at the Northern General Hospital, Edinburgh, while since the end of the financial year covered by the report the Foundation has offered a further £70,000 over eight years to the Rheumatism Research Centre at the University of Manchester, £8,000 to the University of Sheffield for a research fellowship in the Sheffield Centre for the Investigation and Treatment of Rheumatic Diseases and £6,000 to the Oxford Regional Hospital Board for work on the pathogenesis of rheumatic diseases at the Rheumatic Diseases Research Centre, Stoke Mandeville Hospital.

Apart from the grants for new developments in university colleges in the Colonial territories already noted (and which for Ibadan and the West Indies have already led to ag eed schemes), the Foundation allocated £19,821 during the year for expenditure, preferably on biological research, in Australia, New Zealand and South Africa, and £20,475 for four pr› jects in other parts of the Commonwealth. The former includes £2,480 over two years to the University of Sydney for fundamental work in the Department of Organic Chemistry on the biogenesis of natural products, using radioactive tracers, £9,760 over three years for a programme of twin studies at the Walter and Eliza Hall Institute of Medical Research, Melbourne, and £750 a year for three years to the University of the Witwatersrand for research on cardiac surgery in general and mitral disease in particular. Up to £2,000 has been offered to the Aden Protectorate for the advancement of a modern health service, and £1,600 over three years to the University College of the West Indies for an inquiry into the Collembola of Jamaican soils.

Four new grants for research into practical problems, totalling £45,200, and which involve bringing together people from two or more disciplines, were made during the year. A grant of up to £6,500 a year for three years to the Social Rehabilitation Unit at the Belmont Hospital, Sutton, is for an intensive study of the social and cultural background of a series of cases of psychopathy treated in the Unit. £15,000 has been allocated over two years for an independent study of the impact of television on children and young people, and the Foundation has offered £700 for equipment and £1,400 a year for five years to University College, London, for a study of skill in heavy manual tasks by the Departments of Physiology and Psychology.

The miscellaneous projects to which the Foundation allocated £46,178 during the year include grants of £1,000 towards the cost of the Third Congress of the International Association of Gerontology, £2,000 for an industrial accidents survey by the Central Middlesex Hospital and £15,000 over five years to establish a day-centre for the permanently disabled under the supervision of Dr. F. S. Cooksey, of King's College Hospital. New grants for the care of old people include £3,000 a year for three years to the University of Bristol for field-experiments on the employment of elderly workers, £1,500 a year for five years to the Geriatric Unit, Sunderland General Hospital, for a study of physiological and pathological changes in the aged and ageing and £1,750 a year over three years to Cowley Road Hospital, Oxford, for an investigation in the geriatric unit of the mental deterioration of the elderly.

The Royal Society and Nuffield Foundation Commonwealth bursaries scheme established in 1953–54 is designed to complement the Foundation's other awards, more especially by encouraging able young scientists from Great Britain and overseas to work with leaders of research in other overseas parts of the Commonwealth. The scheme is to run for an experimental period of five years, during which the Foundation will contribute £5,000 a year with an initial contribution of £2,500 from the Royal Society. The medical fellowships are being continued on a reduced scale and the dental fellowships and scholarships, biological and sociological scholarships and bursaries are also being continued. The scheme of travelling fellowships for home Civil servants has been renewed for a second five years; but the travelling scholarships and bursaries for United Kingdom farmers will terminate in April 1956.

Grants in continuation of the past programme include £1,000 a year for three years for the investigation of changes which occur at birth in the circulation and

breathing of lambs, £13,200 to the Department of Physics, Birkbeck College, University of London, for two research fellowships for three years for work on protein and virus structure, and £15,000 over five years to the Nuffield Research Group in the Department of Metallurgy at the Imperial College of Science and Technology, University of London, to tide the group over the time until full support is forthcoming from industry and the College for its work on the theory and practice of the extraction of metals from ore.

THE MINING INDUSTRY IN BRITAIN

INTERESTING human documents, though written primarily as the technical record of the work of the Mines Inspectorate in England, are a series of separate reports of the divisional inspectors of five divisions*. Though ostensibly all written with the same objective, they have a refreshing variety, and are indications of the widely differing characters of the separate coalfields, which have required from a centrally controlled authority differences of approach appropriate to local conditions and practices.

Naturally one's first search among these pages must be for the signs of improvement in the statistics of the killed and injured each year that must inevitably, one would think, take place as the result of the considerable attention that is given to the problem of safety. In some divisions one finds an encouraging record of betterment; in others there are to be found an almost discouraging fluctuation of figures from one year to another that must have some deep-seated causes. On reading the separate reports, it very soon becomes apparent that the character of the pits varies widely—thin seams and thick seams, high standards of mechanization, less-developed ones, and wide differences in the character of the mining problems. Perhaps the common problem is the stubbornness of human nature, shown in the repeated instances of accidents due to individual carelessness that has resulted in neglect of regulations framed for their prevention. The major sources of fatal accidents are falls of roof and haulage breakdowns, particularly runaways.

Interesting to the layman in these reports are the many references to the development of new methods and appliances culled from a wide field of experiment carried out both in and outside the industry of coal mining—thus the colorimetric testing of coal dust, the new developments of electric haulage, the ever-advancing character of the new devices for dealing with roof support, the vital problem of the miner, and the many new types of machine for coal cutting. The introduction of machine mining has brought in its train new problems in dust suppression. Following the experience which many mining engineers have had of the effect of water on the mining of coal, there is growing up a body of opinion which believes in this development, which must reduce the use of coal-cutters and shot firing and thus reduce the production of dust. In this application a long hole parallel to the coal-face is drilled, filled with explosive, and then high-pressure water admitted, the objective being to soften the coal.

In spite of all the research and care taken in mine air analysis and other precautions, explosions of fire damp still occur—a pertinent reminder that in no branch of mining technology can it be said that all the problems have yet been solved.

On the surface and underground, good progress has been made in the improvement of the standards of illumination. The removal of glare and shadows is an important feature of such advancement.

Health and welfare, training and education occupy an essential place in the manifold activities of the mining industry. Finally, it is interesting to note that the first electrically driven, horse-cleaning vacuum equipment operated by a certified flame-proof motor and switchgear was installed at the beginning of the year in the underground stables, 3,000 yards from the pit bottom at Hamstead Colliery. Should it be called an equus-cleaner?

R. J. Sarjant

* Ministry of Fuel and Power. Reports of H.M. Inspectors of Mines under the Coal Mines Act, 1911, for the year 1953. North Eastern Division. By C. W. Scott. Pp. ii+30. 2s. net. West Midland and Southern Division. By J. E. Henshaw. Pp. ii+24. 1s. 6d. net. Northern Division. By W. Brown. Pp. ii+30. 1s. 6d. net. North Western Division. By G. Hoyle. Pp. ii+26+5 plates. 2s. net. East Midland Division. By W. B. Brown. Pp. ii+20. 1s. net. (London: H.M. Stationery Office, 1954.)

OVERSEAS FOOD CORPORATION

ANNUAL REPORT

THE Overseas Food Corporation is now concerned solely with investigations, first to ascertain experimentally crop and stock potentialities, with their cultural and husbandry requirements; second, to determine their practical limitations and economics, by applying the findings of the specialists to large-scale trials by farmers; and third, by incorporating in the large-scale trials variations in farming methods, to ascertain which form is likely to prove most productive and yield the greatest return as and when the area is developed. The annual report and statement of accounts for the year ended March 31, 1954*, record steady progress under the first heading. The continued soil surveys, soil fertility studies and the fertilizer experiments are revealing the percentages of the various soil types to be found in the areas, their suitability to the range of crops under trial, their mechanical condition and their response to fertilizer treatment. Considerable progress has been made in the study of rosette disease of groundnuts, and that on the mechanism of resistance of Mwitunde to rosette disease indicates reasonable hopes of selecting a strain combining high yield, low aphid reproduction, low percentage of infective aphids and perhaps some tolerance to the usually severe effect of the virus on yield. Indications are that groundnuts may become an important crop in the rotation at Nachingwea and merit further trial at Urambo in the 1955–56 season.

The second type of investigations was severely checked by the drought throughout Tanganyika during the 1952–53 crop season; but much information was obtained on methods of cultivation desirable under dry-farming conditions. Variations in the third class included experiments with farms of 2,000 acres, 1,500 acres and 1,000 acres, fully mechanized and under European supervision, to determine the pattern of farming best suited to local conditions and the most economical size, while the possibilities of improving peasant farming on a group basis are being examined under the African Tenant Scheme.

* Overseas Food Corporation. Annual Report and Statement of Accounts for the year ended 31st March, 1954. Pp. iv+70. (London: H.M. Stationery Office, 1954.) 2s. 6d. net.

The Corporation maintains close touch with the East African Agricultural and Forestry Research Organization and with the East African Tsetse and Trypanosomiasis Research and Reclamation Organization, as well as with departments of the Tanganyika Government and other bodies; but the work of the Scientific Department is presented on a regional basis in what forms the longest chapter of the report. Among some points of interest are the slight increase in plant population and the big increase in yield obtained in experiments on the control of weeds in maize with 'Fernoxone' at Urambo; the absence of any significant increase in yield of soya bean and maize on deep placement of triple phosphate fertilizer although the standard method of placing fertilizer gave highly significant increase; the identification in South Tanganyika of the maize rust *Puccinia polysora* Underw.; and the continued trials and experiments on the development and improvement of agricultural machinery. Soil fertility studies were restricted to maize, and little progress is reported in the determination of the phosphate status of soils by chemical tests.

METEORIC PARTICLES IN THE ATMOSPHERE

ZDENĚK ŠVESTKA, Astronomical Institute of the Czechoslovak Academy of Sciences, Ondřejov, has a paper in *Bulletin of the Astronomical Institutes of Czechoslovakia* (5, No. 5; Sept. 1, 1954), in which he criticizes F. Link's theory of the fall and absorption influence of meteoritic particles in the atmosphere. This theory has been explained in some of the *B.A.C.* issues over several years, and the time of fall T in seconds through 100 km. may be expressed by Link's approximate formula:

$$\log_{10} T = C - 1{\cdot}5 \log_{10} \rho$$

where $C = 1{\cdot}4$ for metallic particles and $1{\cdot}6$ for stony particles, the radius of the particles in all cases being ρ. According to this formula, the time of fall of 30–100 days would correspond to particles the diameters of which in the limit would conform with the relation $4\mu < 2\rho < 14\mu$. From a study of the absorption influence of particles of different diameters Link also constructed an empirical formula for the number n of particles of iron and silicates of different sizes:

$$\log_{10} n = \text{constant} - 600\,\rho$$

and making use of other data, concluded that the absorption in a layer of meteoric dust is caused predominantly by particles with diameters from 2μ to 6μ.

Švestka has now examined Link's assumptions and deductions and concludes that the latter are inaccurate in many cases. Observations of absorption effects of a dust-layer in the atmosphere during lunar eclipses can be satisfied only when the optical thickness of the layer is equal to 0·01 as a minimum. A table gives for different values of ρ the minimum possible time of fall for which the above optical thickness is assumed, and also the maximum quantity of meteoric matter falling on the earth, which, it is shown, cannot exceed 5×10^{-14} gm. cm.$^{-2}$ sec.$^{-1}$, and proves that it is quite impossible—from the optical point of view—that the observed absorption could be caused by particles larger than 1μ. Link's theoretical conclusions were based on Thomsen's results of collections of atmospheric iron particles, the diameters of which ranged from 10μ to 80μ; but there is very strong evidence from the collection of similar particles in the industrial country of Jena that the meteoritic nature of Thomsen's particles must be open to considerable doubt. It seems probable that meteoric dust is formed by much smaller particles of the order of 10^{-5}–10^{-6} cm., and it is suggested that a study of the sky-light polarization, during and after the activity of strong meteor showers, might provide a decisive answer to the problem under investigation.

THE EARTH'S EXTERIOR ATMOSPHERE AND THE COUNTERGLOW

UNDER this title, the Canadian Defence Research Board has published a second augmented edition of material prepared by E. R. Hope*. In the main this consists of Mr. Hope's translations of recent Russian papers (two more than the first edition) of very great interest concerning observations and theories about the outermost atmosphere of the earth.

The Russian astronomers, Astapovich, Fesenkov, Divari and Karimov, have a particular claim to our attention, for they enjoy in some parts of their country a clarity of the sky which is unrivalled and which is a great asset to the observations concerning the outermost atmosphere and the counterglow. Their revolutionary theories are based in part on new observational discoveries, and their speculations make good use of all the knowledge there is on the subject. They establish that the observational material is in accord with the suggestion that a gaseous tail stretches away from the earth, resembling the tail of a comet, in the direction opposite to that of the sun. They do not suggest that the processes responsible for the heating of the outermost atmosphere or for the acceleration of the gas spraying off in the tail are at all understood.

The translator's foreword of twenty-six pages aims at reviewing the entire subject in a critical manner, and at establishing the relation between these outer atmosphere researches and those connected with magnetic and auroral effects. Much of this could come under severe criticism, and one suspects that most of the authors mentioned would disagree with the arguments presented that oppose their points of view, but equally with those that are in their favour. Those who are concerned with these subjects will have to go over the literature and the arguments for themselves, anyway; and those who would appreciate a passing acquaintance cannot be advised to gain it here, for they are unlikely to appreciate that another review article might, with equal justification, reverse very many of the arguments.

The translations of the Russian papers read well, and make a valuable contribution to the literature accessible to most Western astronomers and to those concerned with upper atmosphere research.

T. GOLD

* The Earth's Exterior Atmosphere and the Counterglow: The Counterglow as Related to Modern Geophysical Theories, with Seven Recent Russian papers. Collected and translated by E. R. Hope. Second edition. (T 65 R.) Pp. xxviii+52. (Ottawa: Defence Research Board (Defence Scientific Information Service), 1954.)

MOBILITY OF MANGANESE, MAGNESIUM AND POTASSIUM IN LEAF TISSUES

By H. C. RUCK and Prof. F. G. GREGORY, F.R.S.

Research Institute of Plant Physiology, Imperial College of Science and Technology, London, S.W.7

BY the use of rooted leaf cuttings, the mobility of metallic elements from fully active leaves can be studied in a simple way. Leaves with axillary buds were detached from potato plants grown in sand culture supplied with nutrient solutions so that the level of the element in the leaves could be controlled. The isolated leaves were set to root in sand or appropriate culture solution, and after fourteen days root formation began, and in most cases the axillary bud grew out into a shoot. At the time of planting out, one leaflet of a pair was removed and analysed. The axillary shoot developed deficiency symptoms when the cutting was grown in solutions deficient in the element under investigation. When the symptoms had become marked, the opposite leaflet of the pair was removed and analysed. The accuracy of the method for determining movement of the element from the leaf depends on the high correlation between mineral content of the paired leaflets. The following mean values were obtained for the distal pair of leaflets in μgm.

Mn (12 leaflets)	2·56	2·46
Mg (10 leaflets)	116	106
K (10 leaflets)	420	360

Manganese

Leaf-bud cuttings with high and relatively low manganese content were used and after rooting transferred to a culture solution without manganese.

Typical symptoms of manganese-deficiency appeared in the shoot after twenty-three days in the low-manganese leaves, and after thirty days in the high-manganese set. The subtending leaf meanwhile remained normally green and without any symptoms. The analyses of the leaflets for manganese (p.p.m. in dry weight) at the beginning and after forty days were as follows:

		At planting out	After 40 days	
High Mn cuttings	grown in Mn deficient solution	150	148	Mean of 8 replicates
Low Mn cuttings	grown in Mn deficient solution	25	20	Mean of 13 replicates

The appearance of the high-manganese cuttings at the end of the experiment is shown in Fig. 1, *A*. The axillary shoot shows severe deficiency, while the subtending leaf remains healthy. In neither series has the concentration of manganese in the subtending leaf fallen to any marked degree, indicating that manganese is not transported from the active leaf to the growing bud.

Magnesium

A similar experiment was carried out using plants grown in a full nutrient solution. The cuttings, after rooting, were grown on either in a solution containing magnesium or completely magnesium-free. Symptoms of magnesium-deficiency appeared in the set grown without magnesium after thirty-seven days in the form of grey spots and scorch on the lower leaves of the shoot. After forty-nine days the experiment ended.

A *B*

Fig. 1. *A*, Leaf-bud cutting from a potato plant grown at high-manganese level, and after rooting transferred to a manganese-free solution; *B*, leaf-bud cuttings taken from a plant grown at high-magnesium level and after rooting transferred to a solution with magnesium (left) or devoid of magnesium (right)

The content of magnesium in a pair of leaflets of the subtending leaf (μgm.) at the beginning and end of the experiment was as follows:

	After 21 days	After 49 days	
Cuttings in solution with Mg	139	435	Mean of 8 replicates
Cuttings in solution without Mg	127	102	Mean of 8 replicates

The appearance of the cuttings is shown in Fig. 1, *B*: on left, cuttings supplied with magnesium; on the right, cuttings grown without magnesium. The leaves of the shoot without magnesium are almost devoid of chlorophyll, while the subtending leaf has remained healthy and without symptoms. The experiment indicates that magnesium is not readily transported from the subtending leaf to the developing bud.

Potassium

Potassium is known to move freely about the plant, and as a check on the method a similar experiment was carried out with this element. Leaf cuttings were taken from plants grown in full nutrient solution, and transferred after rooting either to full nutrient or potassium-deficient solution. The potassium content (μgm.) of leaflets of the mother leaf at beginning of the experiment and after forty-two days is shown below:

	At start	After 42 days	
Cuttings in solution with K	264	673	Mean of 2 replicates
Cuttings in solution without K	276	164	Mean of 11 replicates

In contrast with the behaviour of manganese and magnesium, the potassium content of the subtending

leaf has fallen considerably, and deficiency symptoms appeared not only on the axillary shoot but also on the mother leaf; the former showed brown areas of discoloration and bluish-green colour of the leaves, while the latter showed marginal scorch and necrotic interveinal areas.

STRUCTURE OF TOBACCO MOSAIC VIRUS

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TOBACCO mosaic virus is a rod-shaped virus, of (most frequent) length 3000 A.[1], diameter 150 A.[2], and molecular weight 50 million[1]. It contains 6 per cent by weight of ribonucleic acid, the remainder being protein. Many chemical and physico-chemical studies indicate that the tobacco mosaic virus protein may be built up of identical or nearly identical sub-units of low molecular weight[3–7]. A similar conclusion has been reached as a result of X-ray diffraction studies[3,8]. More recent X-ray work, the results of which are summarized here, provides further evidence for a protein sub-unit of molecular weight consistent with that obtained by chemical methods, and also gives more indication of the arrangement of the protein chains within the sub-unit.

Chemical Evidence

End-group determination using carboxy-peptidase indicates that all C-terminal amino-acids are threonine, and gives a minimum molecular weight of 17,000[4,5]. The amino-acid present in smallest quantity is cysteine. The cysteine content of tobacco mosaic virus is constant in all strains and corresponds to a minimum molecular weight of about 18,000[6]. The molecular weight of the protein fragments obtained by disintegrating the virus with sodium dodecyl sulphate has been given as 10,000–20,000[7], and here again the only C-terminal amino-acid is threonine[6].

Schramm[9] found N-terminal proline in amount corresponding to the C-terminal threonine; but Fraenkel-Conrat and Singer[7] showed that his analytical method was capable of breaking peptide bonds. Unable to detect any N-terminal amino-acid, these authors conclude that tobacco mosaic virus protein has a cyclic structure.

Several authors have shown[10] that, in certain circumstances, a protein of low molecular weight having properties similar to the protein obtained by degradation of tobacco mosaic virus is present in the sap of infected but not of normal plants. This protein has been shown to be capable of aggregating to form rods of the same diameter as the virus but free from ribonucleic acid, and to possess the serological properties of the virus.

Thus a large body of chemical evidence points to the existence in tobacco mosaic virus of a protein building unit of molecular weight between 10,000 and 20,000.

Helical Structure of Tobacco Mosaic Virus

Watson has suggested[8], on the basis of X-ray diffraction studies, that tobacco mosaic virus has a helical structure such that the virus particle can be considered as one giant helical molecule. By analogy with turnip yellow mosaic virus and bacteriophage *T2*, two very different viruses for each of which it is believed that the nucleic acid occupies a central position and is surrounded by a protein shell[11], he suggested that, in tobacco mosaic virus also, the ribonucleic acid may form a central core, around which lie molecules of globular protein in helical array.

Applying the theory of X-ray diffraction by helical structures[12] to the measured positions of the innermost intensity maxima on the layer-lines of the tobacco mosaic virus diagram, Watson concluded that the axial repeat period of 68 A. contains three turns of the helix, on which lie $3n + 1$ protein building units. The observation of an apparently meridional maximum on the 31st layer-line suggested that n was equal to 10. Using this value, and the results of Williams[1], the molecular weight of the protein building unit comes to 35,000—about twice that found by chemical methods.

Infra-red measurements[13] suggested that the protein might be in the form of Pauling α-helices[14] lying perpendicular to the axis of the virus, and Watson pointed out that the pitch of the virus helix, 23 A., would allow of a double layer of α-helices.

X-ray diffraction pictures with improved orientation and resolution have now been obtained, and studied in detail. The diagram shown in Fig. 1 is from a gel of approximately 25 per cent by weight of tobacco mosaic virus, contained in a thin-walled glass capillary of bore 0·4 mm. The intensity distribution on some twenty-five layer lines has been measured, and used for calculating the cylindrically averaged Patterson function shown in Fig. 2*a* and *b*.

The cylindrical Patterson function and the X-ray fibre diagram are simply two ways of presenting the same set of data; in attempting to interpret the data, it is often helpful to look at them in both forms. We shall consider first some information which can be derived by direct inspection of the X-ray diagram.

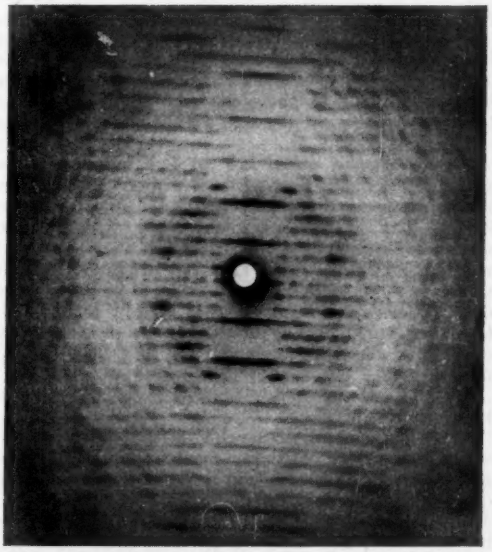


Fig. 1. X-ray diagram of tobacco mosaic virus gel. Orientated specimen obtained from N. W. Pirie's preparation of the virus, Rothamsted culture, incubated with proteolytic enzymes

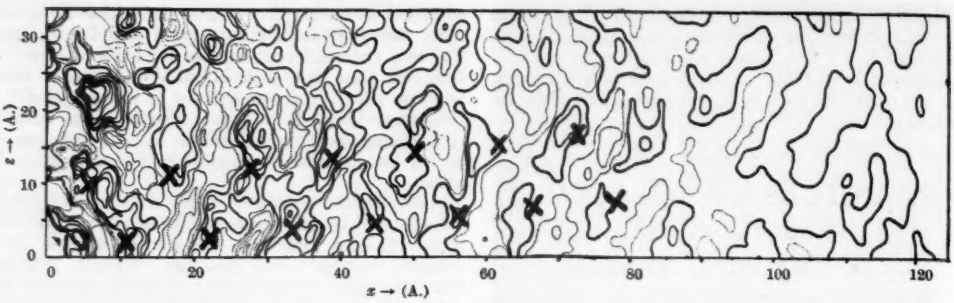


Fig. 2a

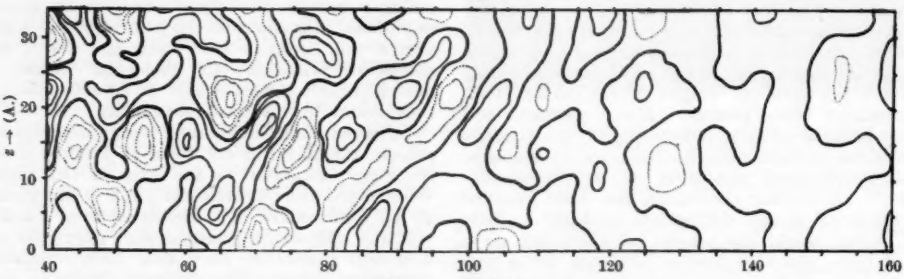


Fig. 2b

Cylindrical Patterson function of tobacco mosaic virus. For Fig. 2b (large values of x) a strong 'artificial temperature factor' has been used

More accurate measurements of the positions of the first maximum on each layer line confirm most satisfactorily Watson's conclusion that there are $3n + 1$ units on three turns of the helix. However, the maximum on the 31st layer line is found not to be truly meridional, but to have a value for ξ/λ of less than 30 A.$^{-1}$. All other maxima stated by Watson to be possibly meridional have now been shown to be off-meridional. The only central maximum not yet resolved into two peaks lies on the 37th layer line, indicating that n may be 12. Although one cannot be sure that this peak, too, could not be resolved with further improvement of technique, and although in a complex structure it is always possible that the maximum looked for may be absent owing to phase-cancellation, it seems fair to state at the present stage that the most probable value of n is 12.

Assuming that there are $3n + 1$ units in three turns of the helix, then, from the observed positions of the innermost maxima on layer-lines of type $3m + 1$, $3m + 2$ (m any integer), an upper limit to n can be obtained. In this way, the first observed maxima on the 1st and 11th layer-lines both show that n cannot possibly be greater than 14. Since observations have been made as far out as the 45th layer-line, this makes it unlikely that a strong central maximum on the layer-line $3n + 1$ has passed unobserved.

If n is 12, the molecular weight of the protein building unit is 29,000.

That it is difficult to be sure of the exact number of units per turn probably means that there is no great fluctuation in electron density in passing from one unit to the next on the same turn of the helix. The pitch of the helix, on the other hand, is quite unmistakable, and undoubtedly there is an important structural discontinuity in crossing from one turn of the helix to the next.

Shape of the Virus Particle

There is some evidence of an external grooving of the virus, the groove following the line of the helix. This is suggested, in the Patterson function, by the peak region lying between 135 and 155 A. in x, a position corresponding with the known diameter of the particle. The shape of this peak, having necks at the base line and at the pitch height and bulging symmetrically on either side of these positions, can best be explained by supposing that the particle has a screw-like contour, and some slight excess of density at the surface. (The excess surface density may well be due to extraneous matter, since the specimen was prepared by evaporation of a more dilute solution.)

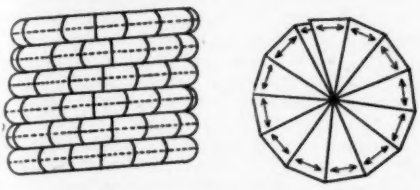
Further evidence of such grooving is provided by the 3rd layer line, the form of which shows that the outermost shell of the virus has very strong fluctuations of density with a period equal to the pitch of the helix. Again, grooving is the simplest explanation. This central region of the 3rd layer-line is found to be greatly modified in X-ray diagrams of air-dried orientated tobacco mosaic virus, as would be expected if the grooves are filled with water in the wet state and with air in the dry state.

It has been suggested, as the result of electron microscope studies, that the cross-section of tobacco mosaic virus may be hexagonal[15]. If this were so, one would expect a dry specimen of the well-orientated virus to form a close-packed mass of uniform density. We find, however, that strongly dried specimens show strong form birefringence (much higher than that of slightly damp specimens), and also very strong equatorial reflexions at spacings of about 70 and 50 A. Both these observations show that there are holes between the particles in the strongly dried material, which is inevitable if the particle contour is helically grooved.

Distribution of Scattering Matter within the Virus

We must now consider the shape of the protein building unit, and the distribution of scattering matter within it. Here some indication can be obtained from the Patterson function. It must be emphasized, however, that in the cylindrically averaged Patterson function of such a complex structure, it is probable that some important structural features will be entirely obscured, and others distorted. The interpretation here suggested, even if partially correct, certainly involves great over-simplification.

The array of peaks indicated by crosses in Fig. 2*a* suggests an end-on view of a double layer of rods of diameter 11 A. This is consistent with the suggestion that the protein unit contains a double layer of α-helices running perpendicular to the axis of the particle. Moreover, the linearity of this long series of peaks suggests that the rods lie in a tangential rather than a radial direction with respect to the particle axis. This type of arrangement is shown schematically in Fig. 3.



(*a*) (*b*)

Fig. 3. Schematic representation of proposed arrangement of protein in tobacco mosaic virus. This drawing is inserted for the sake of clarity; it inevitably involves great over-simplification, as well as the insertion of detail which is of no quantitative significance. (*a*) View of a short length of virus particle, showing units and sub-units on 8/3 turns of the helix. (*b*) Transverse section of virus rod, showing twelve units in one turn of the helix. Arrows indicate principal direction of protein chains in each unit. Ribonucleic acid not shown

Returning to the X-ray diagram, it is seen that, on certain layer-lines, the intensity distribution shows a regular periodicity, with distinct zeros between the maxima. This suggests that the projection of the structure on to an axial plane is approximately centro-symmetric (I am grateful to Dr. F. H. C. Crick for pointing this out), which again points to the sub-division of the main building unit of the helix into two near-equivalent parts related by a diad or pseudo-diad perpendicular to the axis of the particle, the complete structure of the protein being thus a combination of two equivalent co-axial helices.

On the equator, the first four maxima lie close to those which would be given by a rod of uniform density of diameter 150 A. This, together with the regular periodicity of intensity, has made it possible to determine the signs of the first twelve equatorial maxima, and hence to calculate a Fourier projection of the virus. The most prominent feature of this projection (which will be presented and described in detail elsewhere) is a ring of high density at a radius of 55 A. This may suggest that the virus ribonucleic acid lies on this radius. An alternative explanation is that the ribonucleic acid in tobacco mosaic virus is heavily hydrated and lies at the centre, while the heavy shell of radius 55 A. is simply a region of low hydration.

It is often supposed that there is no internal hydration in tobacco mosaic virus. However, when the air-dried virus is strongly dried at room temperature, there is a loss of weight of about 10 per cent. Moreover, the scattered intensity on layer lines $3n + 1$ and $3n + 2$ becomes much weaker, showing that the degree of order within the protein building unit is reduced. This effect is comparable with the deterioration which occurs in the X-ray diagrams of single crystals of protein when the water of hydration is lost, and suggests that the virus protein also is to some extent hydrated.

A detailed study of the 6th layer line in the tobacco mosaic virus diagram shows that the strong central region is mainly due to a second-order Bessel function contribution from a cylindrical shell of radius 55 A. This coincides with the high-density shell revealed by the Fourier projection, and it thus appears that the high-density shell must have a strong periodicity of 11 A. in the axial direction.

To summarize, X-ray diffraction studies indicate that the protein of tobacco mosaic virus is in the form of structurally equivalent units of molecular weight about 29,000 arranged on a helix of pitch 23 A., there being $3n + 1$ such units on three turns of the helix, with n probably equal to 12. These units appear to be subdivided, along a plane approximately perpendicular to the axis of the helix, into two equivalent or near-equivalent sub-units. The molecular weight of these sub-units is consistent with the minimum molecular weight obtained by chemical methods.

There is an important structural discontinuity between one turn of the helix and the next, and this appears to be associated with an external grooving of the particle. This feature of the structure, which gives the virus a rather large external surface, may perhaps account for the surprising variety and extent of chemical modifications which it is possible to make in tobacco mosaic virus without breaking up the particle and, in some cases, without destroying its infectivity[16]. There is thus reason for hoping that further chemical work on the accessibility of the different amino-acids, together with X-ray studies of the chemically modified forms, may help to elucidate not only the configuration of the protein chains, but also the positions of certain amino-acids in the virus.

I am grateful to Prof. J. D. Bernal for his interest and encouragement, to Mr. N. W. Pirie for providing me with the purified tobacco mosaic virus, and to many American workers at Berkeley, Pasadena, St. Louis and elsewhere, for stimulating discussions.

[1] Williams, R. C., Backus, R. C., and Steere, R. L., *J. Amer. Chem. Soc.*, **75**, 202 (1951).
[2] Bernal, J. D., and Fankuchen, I., *J. Gen. Physiol.*, **25**, 111 (1941).
[3] Schramm, G., *Z. Naturf.*, **2b**, 112 and 249 (1947).
[4] Harris, J. I., and Knight, C. A., *Nature*, **170**, 613 (1952).
[5] Harris, J. I., and Knight, C. A. (private communication).
[6] Knight, C. A., "Advances in Virus Research", **2**, 153 (1954).
[7] Fraenkel-Conrat, H., and Singer, B., *J. Amer. Chem. Soc.*, **76**, 180 (1954).
[8] Watson, J. D., *Biochim. Biophys. Acta*, **13**, 10 (1954).
[9] Schramm, G., and Braunitzer, G., *Naturforsch.*, **8b**, 61 (1953).
[10] Takahashi, W. N., and Ishii, M., *Amer. J. of Botany*, **40**, 85 (1953). Commoner, B., Yamada, M., Rodenberg, S. D., Wang, T.-Y., and Basler, E., *Science*, **118**, 529 (1953). Jeener, R., Lemoine, P., and Lavand'homme, C., *Acta Biochim., Biophys.*, **14**, 321 (1954).
[11] Markham, R., Discuss. Faraday Soc., **11**, 221 (1951). Hershey, A. D., and Chase, M., *J. Gen. Physiol.*, **36**, 39 (1952).
[12] Cochran, W., Crick, F. H. C., and Vand, V., *Acta Cryst.*, **5**, 581 (1952).
[13] Fraser, R. D. B., *Nature*, **170**, 491 (1952).
[14] Pauling, L., Corey, R. B., and Branson, H. R., *Proc. U.S. Nat. Acad. Sci.*, **37**, 205 (1951).
[15] Williams, R. C., *Biochim. Biophys. Acta*, **8**, 227 (1952).
[16] Anson, M. L., and Stanley, W. M., *J. Gen. Physiol.*, **24**, 269 (1941). Miller, G. L., and Stanley, W. M., *J. Biol. Chem.*, **146**, 331 (1942). Knight, C. A., *J. Biol. Chem.*, **192**, 727 (1951).

LETTERS TO THE EDITORS

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The 'Horizon' of the Steady-State Universe

In a recent article on "The Age of the Universe" in *Nature*[1] there has been a call for a further explanation of the nature of the 'horizon' or the 'size' of the universe as it is defined in the steady-state theory. The subject is mathematically quite clear, and geometrical properties follow from the fact that the de Sitter space is the applicable one. Thus in the original papers on the subject by Bondi and Gold[2] and by Hoyle[3] there is no ambiguity. Pirani[4] has published a lucid mathematical discussion of the 'horizon', or the observable size of that type of universe. The present discussion is therefore merely a descriptive supplement.

There is no simple answer to the question: 'How big is that universe?' The theory is concerned only with quantities that can be measured observationally, or that could be so measured were it not for some obviously only technical limitation. Some of the questions that may be asked are discussed below.

(1) 'Out to what distance could we now see galaxies?' With any given observing apparatus of fixed limitations as to the energy density and the frequency of the light required for an observation, this will be a finite range. The number of galaxies that can be seen is then also finite. This will be so whatever the actual limits of the apparatus may be, so long as it requires finite amounts of energy for an observation. An improvement of the sensitivity of the apparatus would always give an increase of the range (but not in proportion).

(2) 'If we continued observations with a given apparatus for a very long time, what changes would we see?' In the course of time, the farthest galaxies that we could see will drop out of the observable set because their light will appear fainter and of lower frequency until it is below the threshold of the apparatus. At the same time other galaxies will become brighter as they grow bigger, and newly formed ones will become visible. Originally bright ones will fade towards the limit of observability. Statistically, the population will remain the same, though there will be losses and gains. The 'observational horizon' will always be at a finite range, constant for any given instrument, but greater the more sensitive the instrument.

(3) 'If we sent out a powerful light pulse now, where could it be received?' Such a signal will reach that set of galaxies which are at present nearer than a certain distance (given by Hubble's constant) from us. That is a finite number. But it will also reach all those galaxies that will have formed within the expanding space defined by the first set, in time to intercept the light. That is an infinite number. If reception is to imply recognition, and therefore a finite amount of energy at the receiver, this would limit the number to a finite one; but there is no limit in principle to the number of galaxies that could be informed of our pulse by the use of intermediate relay stations.

(4) 'Is there a last moment before which a light pulse has to be emitted here to assure its arrival at a specified galaxy?' Yes. If the signal is sent later than that moment it will not get to that galaxy. (This is not a question of observational technique.)

(5) 'Is there a last moment for the reception of light signals from another galaxy?' No. There is no last moment of reception defined in the theory. The last signal emitted by another galaxy that could be received here would, however, be drawn out in time so that it would take an infinite time for it to arrive, however short a pulse it may have been at its emission. This absence of a defined instant at which reception must cease does not mean that the act of disappearance is in doubt, but only that the moment at which it occurs is related to the particular method of observation. A change to more sensitive methods of observation would delay the disappearance of any one galaxy, but provided the method of observation is kept the same, the mean rate of disappearance from view will be constant (and equal to the rate at which new ones are appearing in the realm surveyed by that instrument).

So far as any actual, or in principle possible, observation is concerned, that universe is finite. The flow pattern of information there is analogous to that in a population which has a finite number of members at any instant, but which is in a steady state for all time. If I were a member of such a population I could obtain information (say, in writing) from an unlimited set that have lived before now, and I could leave information for an unlimited set in the future. But there would only be a finite number with whom I could now have a two-way conversation. Any one of that number will also belong to one, or more generally to both, the unlimited sets.

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[1] *Nature*, **175**, 69 (1955).
[2] *Mon. Not. Roy. Astro. Soc.*, **108**, 252 (1948).
[3] *Mon. Not. Roy. Astro. Soc.*, **108**, 372 (1948).
[4] *The Observatory*, **74**, 172 (1954).

Mr. Gold's statement is very clear, and those interested in cosmology will be very grateful to him for making it. Unfortunately, however, it only increases the uncertainty which has arisen regarding the actual implications of the theory with respect to the observable horizon, since it appears to be in direct conflict with statements made in the paper by Hoyle which Mr. Gold now cites as one of "the original papers on the subject". In that paper Hoyle says: "Extragalactic nebulæ are continually passing out of the observable universe . . . The oldest condensation within the observable universe . . . has an age of about $1{\cdot}5 \times 10^{10}$ years". If a nebula passes out of the observable universe there must have been a time when it was within it (that is, was observable), and a later time when it was not observable. Hence there must have been a time when it ceased to be observable. But Mr. Gold now says: "Is there a last moment for the reception of light signals from another galaxy? No. There is no last moment of reception defined in the theory".

It is clear from Hoyle's paper that the "passing out of the observable universe" was not introduced as an effect of instrumental imperfections: it has been generally interpreted as an effect of the nebula reaching, at a finite distance and within a finite time, the velocity of light. Statements to this effect are numerous. For example, Dingle, speaking

in February 1953, assumed that the theory required that "nebulæ are continually receding into inaccessibility by surpassing the speed of light"[1]. Still earlier, in May 1952, the Astronomer Royal, in describing the theory at a Friday Evening Discourse at the Royal Institution[2], said that "at a distance of about two thousand million light years the rate of expansion becomes equal to the velocity of light. At that distance we have, therefore, an observational horizon, beyond which we can never see. . . . As the creation of matter is at the rate needed to keep the mean density of matter in the Universe constant, the rate at which galaxies are being born just balances the rate at which they are lost to view". Neither of these statements, which Mr. Gold's letter now contradicts, seems ever to have been corrected.

If, as Mr. Gold now says, "A change to more sensitive methods of observation would delay the disappearance of any one galaxy", what is the meaning of Hoyle's statement that "the oldest condensation within the observable universe . . . has an age of about $1{\cdot}5 \times 10^{10}$ years"? What particular method of observation corresponds to this figure?

In view of these and other questions that will doubtless arise when the whole matter is reviewed in the light of Mr. Gold's new explanation, the need seems imperative for a clear and authoritative statement either reconciling the earlier and later assertions or else stating which is to be accepted as the true postulate of the theory.

THE WRITER OF THE ARTICLE

[1] *Mon. Not. Roy. Astro. Soc.*, **113**, 404 (1953).
[2] *Proc. Roy. Inst.*, **35**, 336 (1953).

Influence of Liquid Films on Fibre Friction

Bowden and Tabor[1] have shown that the adhesive force between a smooth sphere and a smooth plane due to a surface film of liquid is independent of the amount of liquid held between the surfaces. This is not true for the case of a cylinder in contact with a plane, when the adhesive force per unit length of cylinder is

$$A = 4\nu\sqrt{R/r}, \qquad (1)$$

where R is the cylinder radius, r the radius of curvature of the liquid meniscus and ν the surface tension. According to (1), A will increase as r is reduced by decreasing the amount of liquid present. The adhesion will not become infinite, but its maximum value will be determined by the tensile strength of the liquid or by the surface roughness.

The effect is easily demonstrated for a relatively thick glass fibre adhering to a glass plate by adding water and measuring the adhesion as the water evaporates. With a fibre 0·1 cm. in diameter, values of A up to 2 gm./cm. are readily obtained. The adhesion cannot, however, be measured directly in this manner for fine textile fibres; but it can be measured indirectly in so far as it modifies the apparent frictional coefficient when rubbing takes place on a smooth surface in the presence of a liquid film.

Fibre frictional coefficients are generally measured by the 'bollard' method for which the well-known relation,

$$T_1/T_2 = \exp \mu_A \theta, \qquad (2)$$

is employed, where T_1, T_2 are the fibre tensions, θ is the angle of contact between fibre and cylinder and μ_A the coefficient of friction. In the presence of an adhesion force A, relation (2) will take the form,

$$\frac{T_1 + A\rho}{T_2 + A\rho} = \exp \mu\theta,$$

when ρ is the cylinder radius and μ the true coefficient of friction. Then by measuring values of T_2 for two different values of T_1, it is possible to determine both A and μ. Some results obtained using a nylon fibre and a polished glass cylinder are shown in Table 1. No attempt was made to fix the thickness of the oil film, which was simply reduced in thickness by wiping with a clean cloth. The oil used had a viscosity of about 1 c.g.s. unit and a surface tension of about 30 dynes/cm.; the cylinder diameter was 5·9 cm.

Table 1

Oil film	μ	A	μ_A, from (2)
As originally applied	0·4	0·10 gm./cm.	0·62
Cylinder wiped once	0·4	0·17 gm./cm.	0·79
Cylinder wiped again	0·4	0·26 gm./cm.	1·10

In the case of the thinnest oil film, the experiment was repeated using a wool fibre, and the values $\mu = 0{\cdot}4$ and $A = 0{\cdot}03$ gm./cm. were obtained.

It is plain that the surface roughness of the wool fibre resulting from the surface scales has eliminated adhesion effects to a large extent.

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[1] Bowden, F. P., and Tabor, D., "The Friction and Lubrication of Solids", 300 (Clarendon Press, 1950).

Non-linear Microphonic Response of Labyrinth Organs to Stimuli consisting of Two Pure Tones

IN a study of the microphonic effect of the lateral line of fishes[1], we found a remarkable response to a stimulus consisting of two pure sine waves acting at the same time on the sense organ. These effects are demonstrated by Fig. 1, curves *A–C*.

The most interesting aspects of these curves are: (1) The frequency of the response (*A* and *B*) is twice the frequency of the stimulus. (2) In the combined effect (*C*), the response to the high frequency is large at the negative peaks and small at the positive peaks; the latter correspond (approximately) to the equilibrium position of the organ. (3) The maximum response to the high frequency in *C* is much larger than if this frequency is presented alone (*B*), with the same amplitude. The quotient of the two responses will be called the 'amplification'. This amplification depends on the amplitudes of *a* and *b*.

We are still convinced that the explanation of the double frequency given in our earlier paper[1] is correct. It is not found in the microphonic effect of the cristæ of the semicircular canals and of the

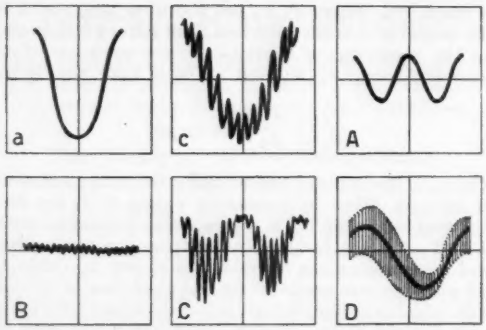

Fig. 1. Curve *a*: Waveform of the low frequency. *c*: Waveform, if a high frequency with smaller amplitude is superimposed on the low frequency. *A*: Response of the lateral line organ to stimulus *a* (double frequency). *B*: Response to the high frequency alone. (Oscillogram *B* was photographed for another frequency, but it has the right amplitude.) *C*: Response to *c*. *D*: Response of a labyrinth organ to stimulus *c* (schematical)

cochlea. The further quantitative analysis of the phenomena, however, revealed fundamental difficulties in the explanation which was given for the effects under (2) and (3). This will be described in more detail in the thesis of one of us (J. W. K.). Hence it seems probable that these two effects are due to the sense cells themselves, so that the labyrinth organs should also give a similar response. Indeed, this was checked for the cristæ of the semicircular canals as well as for the cochlea of the pigeon by one of us (D. R. U.). This has now been checked for mammals with positive result.

There are some minor differences between the cochlea and the other organs studied. Though in all cases a 'zero-point' in the output for the high frequency is found, it is generally on the rising part of the curve for the cochlea, whereas it is sometimes on the descending part of the curve for the cristæ. For the lateral line it is close to the top of the curve. The optimal 'amplification' (see above) is about 6 for the lateral line, between 3 and 8 for the cristæ and between 1 and 1·7 for the cochlea. It is about 1 for less optimal values of the amplitudes of the two frequencies.

Though the experiment described here is very simple, we have not found any earlier report of it in the literature. It proves that the sense organ gives a non-linear response; a good microphone should give a response similar to the input curve *c*. We have constructed electronic models giving the same typical response, and the possible relations between these models and physiological processes are being investigated. They will be published elsewhere in more detail, together with a full account of the experiments described here.

Our thanks are due to Prof. Eelco Huizinga, director of the Otological Clinic, for his interest.

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[1] de Vries, Hl., Jielof, R., and Spoor, A., *J. Physiol.*, **116**, 137 (1952).

Interpretation of Differential Thermal Curves of Mixed-layer Minerals of Illite and Montmorillonite

Mixed-layer minerals of illite and montmorillonite have been known for more than a decade now, and new examples are constantly being reported[1]. The identification of these minerals is based largely on X-ray examination using the tables and curves of Brown and MacEwan[2] or the method of MacEwan[3] for random structures; the methods for ordered structures are more direct. Most workers publish differential thermal curves as supporting evidence for the presence of an interlayered structure, and in these curves there are usually two endothermic peaks in the region between 500° and 700° C., which are taken to represent loss of hydroxyl water from the separate illite and montmorillonite layers. However, a detailed examination of published and unpublished differential thermal curves of these materials shows that the sizes of the endothermic peaks in the 500°–700° C. region bear no relation to the proportion of illite to montmorillonite found by X-ray examination. Order can be attained only by dividing the curves into two series, in one of which the main endothermic peak lies between 525° and 625° C. and in the other between 650° and 725° C. The curves in each series still bear no relation to the proportion of illite and montmorillonite, but there is an important structural difference between the groups not revealed by X-ray examination which appears to be of wide significance.

The subdivision requires the existence of anomalous illites[4] and montmorillonites[5] in which the temperatures of the endothermic peaks are reversed in the region between 500° and 700° C. Furthermore, it is logical to assume that these anomalous minerals have arisen owing to mineral transformations that have proceeded as in the following scheme (full lines).

Series I	Series II
'Illite'-like differential thermal curves	'Montmorillonite'-like differential thermal curves
Structure probably disordered	Structure probably ordered
← - - -	
Normal illite	Abnormal illite
Intermediates	Intermediates
Abnormal montmorillonite	Normal montmorillonite
- - - →	

If this thesis be correct, differential thermal analysis will indicate the direction in which mineral transformations are taking place in mixed-layer minerals of illite and montmorillonite; several examples have been put to test with success.

Transformations between series I and II are possible but difficult, thus explaining why the second endothermic peak associated with the main one in the region 500°–700° C. in each series is usually poorly developed. It can be performed artificially for a normal montmorillonite by firing material to 800° C. and rehydrating the product in steam[6], whence abnormal montmorillonites are obtained. It should be noted that this is a disordering process and suggests the possibility that the structures of series I are disordered and those of series II ordered. Order–disorder can be of several types and need not be the same for artificially prepared abnormal montmorillonites as for naturally abnormal ones. That which is believed to be of importance for the latter is order–disorder of the substitution cations, which brings about differences in bonding of hydroxyls as indicated by Kerr *et al.*[7].

On the present theory it would not be necessary for the abnormal montmorillonites recently described by Bose and Sengupta[5] to have iron contents intermediate between that of nontronite and normal montmorillonite to explain the lower differential thermal peak in the region 500°–700° C. Another naturally abnormal montmorillonite known to me has no iron at all, and the iron content of the sample used by Hill[6] could not have been changed during his experiments. Chemical data indicate also that current theories of the effect of substitution of silicon by aluminium in tetrahedral layers do not explain the thermal effects of anomalous illites and montmorillonites. A disorder–order process seems worthy of serious consideration and study.

In the scheme suggested, a cycle of transformations is postulated, and this cycle should be reversible; but as yet no ways of performing the disorder–order transformation artificially have been found. However, this concept should enable one to plan experiments designed to transform illite and montmorillonite (normal forms) into each other more successfully than has been done in the past.

A more detailed account of these ideas is given in a chapter on clay mineral mixtures and mixed-layer minerals in the forthcoming monograph of the Mineralogical Society of Great Britain on "The Differential Thermal Investigation of Clays".

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[1] Bystrom, A. M., *Nature*, 173, 783 (1954). Cole, W. F., and Carthew, A. R., *J. Roy. Soc. Tas.*, 87, 1 (1953). Heystek, H., *Min. Mag.*, 30, 400 (1954). Weaver, C. E., *Bull. Geol. Soc. Amer.*, 64, 921 (1953).
[2] Brown, G., and MacEwan, D. M. C., in "X-Ray Identification and Structures of Clay Minerals", edit. G. W. Brindley, 266 (1950).
[3] MacEwan, D. M. C., *Nature*, 172, 364 (1953).
[4] Mackenzie, R. C., Walker, G. F., and Hart, R., *Min. Mag.*, 28, 704 (1949).
[5] Bose, A. K., and Sengupta, P., *Nature*, 174, 40 (1954).
[6] Hill, R. D., *Trans. Brit. Ceram. Soc.*, 52, 589 (1953).
[7] Kerr, P. F., Kulp, J. L., and Hamilton, P. K., "Differential Thermal Analysis of Reference Clay Mineral Specimens", Report 3, American Petroleum Institute Project 49 (Columbia University, New York, 1949).

Anhydrous Hydrogen Fluoride as a Collagen Solvent

It has been reported[1] that hide collagen and other proteins dissolve in anhydrous hydrogen fluoride. The fact that some proteins, like insulin, were recovered with up to 80 per cent of their initial biological activity, after solution in this solvent, suggested that collagen might dissolve without denaturation. The ability to reconstitute characteristic collagen fibrils from solution was used as the criterion of the absence of denaturation.

Dry, purified, unlimed, steer-hide collagen was introduced into the middle flask of a train of three polyethylene flasks. These flasks were connected to each other, to the hydrogen fluoride tank, and to a nitrogen tank by polyethylene and copper tubing to form a gas-tight apparatus. After introduction of the sample, the apparatus was flushed with dried nitrogen for 48 hr. Hydrogen fluoride was distilled from the tank into the nearest flask and then carefully redistilled into the flask containing the sample. After eleven days at 0° C., some of the collagen had dissolved. Using anhydrous conditions, some of the supernatant liquid was withdrawn into a fourth polyethylene flask. The hydrogen fluoride was evaporated from the two flasks anhydrously and the residues examined.

The residue from the supernatant liquid was a transparent film which gave a gelatin-like high-angle X-ray diffraction diagram. This dry film was soluble in water. A distilled water solution of this film produced precipitates when ammonium sulphate and phosphotungstic acid solutions were added. These precipitates were examined in the electron microscope but nothing fibrous was observed.

The distilled water solution was further examined by dialysis against 1 per cent and 10 per cent solutions of sodium chloride, tap water and distilled water. Bovine glycoprotein was added to another portion, and this mixture was dialysed against distilled water[2]. Precipitates were not obtained in these reconstitution tests, and nothing fibrous was seen on electron microscopic examination.

We conclude that anhydrous hydrogen fluoride does dissolve steer hide collagen, but that the solution occurs with denaturation.

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[1] Katz, J. J., *Nature*, 173, 265 (1954).
[2] Highberger, J. H., Gross, J., and Schmitt, F. O., *Proc. U.S. Nat. Acad. Sci.*, 37, 286 (1954).

Reactions of Hyponitrites and Nitrites

Experiments carried out by Oza and Oza[1] with silver and anhydrous strontium hyponitrites and dinitrogen tetroxide at 0°, 30° and 140° C. show the production, in the gas, of both nitrous oxide and nitrogen, which are among the thermal decomposition products of these hyponitrites. It appears, therefore, that these hyponitrites undergo fission into their normal decomposition products under the impact of the molecules of nitrogen tetroxide or dioxide. The oxide and the nitrite so formed then react with the nitrogen tetroxide or dioxide to yield their relevant products of the reaction, while the gaseous products of the primary fission remain unaltered and their presence is shown by analysis of the gas.

It is known that sodium hyponitrite decomposes as follows:

$$3Na_2N_2O_2 = 2Na_2O + 2NaNO_2 + 2N_2$$

The hydrated salt produces some nitrous oxide also[1]. Thus the mere presence of water has the effect of converting some of the nitrogen into nitrous oxide. Calcium hyponitrite tetrahydrate, which normally decomposes into nitrite, nitrate, oxide, nitrous oxide, nitric oxide and nitrogen at 330°, is shown to decompose, yielding the same products, when kept for some time in the vicinity of 100°. It appears, therefore, that the decomposition of hyponitrites can be induced by causes other than heat, for example, by molecular agitation of some kind. The hyponitrites of strontium, silver and mercury have also been systematically investigated by Oza and Thaker and found to yield similar products when decomposed by heat.

In another investigation silver oxide was isolated in the decomposition products of silver nitrite, although it had not been found by E. Divers[2]. The probable formation was indicated in a thesis mentioned in *British Chemical Abstracts* (1, 245; 1942); the details were not published and reference to the thesis shows that the oxide was isolated when silver nitrite was heated in a current of dry air at 550°, when the decomposition is extremely rapid. His silver oxide may have been a secondary product; silver, in a finely divided state, can react with the oxygen of the air[3]. Oza, Oza and Thaker have isolated silver oxide in the decomposition of silver nitrite at 130° in an atmosphere of oxygen at 11 cm. mercury pressure. Addition of finely divided silver to the decomposing nitrite did not alter the results. It is obvious that the atmosphere immediately in contact with the decomposing nitrite is a mixture of nitrogen dioxide and oxygen, which can produce only nitrate but not oxide. The presence of oxygen in the atmosphere surrounding the decomposing nitrite has the effect of removing nitric oxide, a product of the decomposition, which, if left as such, destroys the silver oxide.

The action of nitric oxide on oxides of silver, mercurous and mercuric mercury, and calcium has been investigated by Oza and Thaker and Oza and Oza. The oxides were heated, at suitable temperatures ($< 300°$), for varying periods of time, in an atmosphere of nitric oxide at different pressures. The experiments demonstrated the formation of nitrite as the primary product of the reaction. Nitrogen and nitrogen dioxide are produced in the gas and their formation is greatest when nitric oxide is at a pressure tending to zero. There seems little doubt, therefore, that the molecule of nitric oxide decomposes and the nitrogen dioxide found in the gas arises in this way. The formation of nitrite may also involve a prior orientation of the nitric oxide molecule on the surface of the metal oxide to bring about what is essentially a peroxide structure[4]. Nitrogen is also formed from nitric oxide in contact with nitrite[1]. In the case of silver oxide, which has, among the oxides now studied, the most readily detachable oxygen, this provides the most noteworthy reactions.

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[1] Oza, T. M., and Oza, V. T., *J. Chem. Soc.*, 909 (1953).
[2] Divers, E., *J. Chem. Soc.*, **24**, 85 (1871).
[3] Benton, A. E., and Drake, L. C., *J. Amer. Chem. Soc.*, **54**, 2186 (1932).
[4] Addison, C. C., and Lewis, J., *J. Chem. Soc.*, 1874 (1953).

A Simple Method for the Determination of Glycogen in Liver

The methods used for the determination of liver glycogen can be divided into two general groups: the glycogen can be determined in its original state[1,2], or after its hydrolysis to form simple sugars[3,4].

Recent investigations indicate that liver glycogen is built up of two physiologically different components. One of these is protein-bound, constant and can be extracted by boiling with alkali. The other is 'free', and physiological alterations are mainly associated with this fraction, which can be extracted with trichloracetic acid[3,5]. The latter method has been recently regarded by several authors as an accurate method for the determination of quantitative changes in the liver glycogen[3,6,7].

On the basis of our experiments carried out during the past year, we recommend the following method for the determination of glycogen. We use 10 per cent (v/w) trichloracetic acid, physiological saline and absolute alcohol. 2–3 gm. aliquots of the livers of rats killed by decapitation are quickly homogenized in a mortar previously weighed and containing 2 ml. of trichloracetic acid. The weight of the liver sample is established by reweighing the mortar, and the quantity of trichloracetic acid made up to 1 ml./gm. liver. To this 1 ml./gm. liver mixture physiological saline is added and the homogenization completed. After filtration through filter paper, 1·5 ml. of alcohol is added to 1·2 ml. of the filtrate. (In the case of high liver-glycogen concentrations, appropriate dilutions of the filtrate may be used). The turbidity arising on shaking and after standing for three hours is measured nephelometrically with a yellow filter in a suitable colorimeter. The original (or the diluted) filtrate in a 1·2–1·5 dilution with water serves as blank control.

Calibration curves were established with dilutions of a commercial sample of glycogen and with three samples originating from different groups of rat livers. The regressions of all the four samples proved to be identical. This shows a great advantage above the van der Vies iodine method[3], as with the latter even livers of single animals of the same species gave different colour reactions. We have ourselves investigated the use of this method[8].

In recovery experiments, $103·6 \pm 3·85$ per cent of added glycogen was regained (average of nine determinations). The values obtained by our method were compared with the values for the same livers as determined by the hydrolytic method[3,9]. According to our experiments, in the case of low liver glycogen, the relative proportion of trichloracetic acid glycogen proved to be low, whereas in the case of high liver glycogen the two methods gave nearly the same results. This observation is in accordance with the results of other authors[3,10].

Details of this work will be published in *Acta Physiologica Acad. Sci. Hung.*

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[1] Wagtendonk, W. J. van, Simonsen, B. H., and Hatchett, P. L., *J. Biol. Chem.*, **163**, 301 (1946).
[2] van der Vies, J., *Biochem. J.*, **57**, 410 (1954).
[3] Good, C. A., Kramer, H., and Somogyi, M., *J. Biol. Chem.*, **100**, 485 (1933).
[4] Seifter, S., *et al.*, *Arch. Biochem.*, **25**, 19 (1950).
[5] Merrick, A. W., and Meyer, D. K., *Amer. J. Physiol.*, **177**, 441 (1954).
[6] Kleij, B. J. van der, *Biochim. Biophys. Acta*, **7**, 481 (1951).
[7] Bloom, W. L., *et al.*, *J. Biol. Chem.*, **188**, 631 (1951).
[8] Gyermek, L., and Fekete, G., *Acta Physiol. Acad. Sci. Hung.* (in the press).
[9] Nelson, N., *J. Biol. Chem.*, **153**, 375 (1944).
[10] Kerly, M., and Ottaway, I. H., *J. Physiol.*, **123**, 516 (1954).

In vitro Synthesis of Ribonucleic Acid in Reticulocytes

We have been studying the concurrent synthesis *in vitro* in rabbit reticulocytes of hæm, globin and the non-hæmoglobin proteins. Using methylene-labelled (^{14}C) glycine the degree of ribonucleic acid synthesis also could be measured. The technique devised may be useful to others faced with the

problem of measuring the radioactivity of very small amounts of substances in very dilute solution. It has enabled us to observe the synthesis of five nucleotide components of ribonucleic acid, beginning with 8 ml. of reticulocytes.

Reticulocytes were produced in a rabbit by the injection of phenylhydrazine; these were washed free of plasma in Krebs solution by centrifugation, and then incubated for two hours at 37·5° under 95 per cent oxygen and 5 per cent carbon dioxide in a Krebs solution reaction mixture containing the following, which have been found to stimulate amino-acid incorporation into the proteins and hæm synthesis: certain amino-acids, Fe^{++}, fructose-alanine, and plasma dialysate[1]. At the end of the incubation, the cells were washed five times by suspension and centrifugation in a large volume of Krebs solution and then to the sedimented cells was added 100 ml. of 7 per cent trichloracetic acid at 4° which dissolves all the free nucleotides. The precipitate was dissolved in 1 *N* sodium hydroxide (0·25 ml. per ml. of cells used) and allowed to stand overnight at room temperature. The ribonucleic acid is thus hydrolysed to its nucleotides. The deoxyribonucleic acid and proteins are precipitated from this solution by 7 per cent trichloracetic acid. The supernatant solution is extracted with ether in order to remove the trichloracetic acid and then the Na^+ is removed from it by the addition of 20 mgm. of 'Dowex-50' H^+[2]. The nucleotides were then isolated by adsorption on, and serial elution from, 'Dowex-1' according to the procedure of Cohn[4]. Cytidylic and adenylic acid *a* were eluted with 0·1 *M* formic acid, adenylic acid *b*, guanylic and uridylic acids by 1·0 *M* formic acid. The fractionation was followed by measuring the light absorption at 260 mμ and the different nucleotides were identified by the ratio of optical densities at 260 and 280 mμ.

The following procedure was used for measuring the radioactivity of each nucleotide isolated as above. 20 mgm. of 'Norit' was suspended in water and then spread evenly on a circle of filter paper, 20 mm. diameter, by suction filtration through a sintered glass funnel with a removable collar. The solution containing the nucleotide was filtered through several times until no more nucleotide was removed. The amount of nucleotide adsorbed was determined by the diminution in optical density at 260 mμ in the filtrate; 20 mgm. of 'Norit' retains about 1 mgm. of nucleotide. For accurate measurement of the radioactivity the charcoal must be saturated with nucleotide; therefore the filtrate must finally contain some nucleotide which the charcoal does not remove. It was determined in separate experiments that no free glycine (^{14}C-labelled) was retained on the charcoal in this procedure; this eliminated any possible slight contamination of the 'Dowex-1' fractions by radioactive glycine. The paper with the charcoal on it was then placed on a circular aluminium cup, spread with silicone grease to prevent curling of the paper, and dried. Radioactivity was measured in a Geiger–Müller end-window counter, using glycine with 24×10^6 counts per minute per millimole.

The different nucleotides have the following specific activities:

Nucleotides	Counts/minute per millimole
Adenylic acid *a*	2,620
Adenylic acid *b*	2,295
Guanylic acid	3,620
Cytidylic acid	1,135
Uridylic acid	515

This incorporation is about 1–6 per cent of the incorporation of glycine per residue of glycine in the globin.

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[1] Borsook, H., Abrams, A., and Lowy, P. H., *J. Biol. Chem.* (submitted for publication).
[2] Borsook, H. Deasy, C. L., Haagen-Smit, A. J., Keighley, G., and Lowy, P. H., *J. Biol. Chem.*, **196**, 669 (1952).
[3] Loring, H. S. (personal communication).
[4] Cohn, W. E., *J. Amer. Chem. Soc.*, **72**, 1471 (1950).

Relation of the Ground Substance of the Central Nervous System to the Blood – Brain Barrier

Between the cell bodies, the neuroglial fibres, and the nerve processes of the central nervous system, there are spaces. These spaces are filled with a ground substance of a carbohydrate – protein nature, revealed by staining with the periodic acid – Schiff reagents[1]. The concept of a blood – brain barrier was formulated when it was discovered that intravenously administered trypan blue stains extensively other organs of the body, but does not stain the brain[2]. Numerous subsequent investigations have demonstrated that trypan blue, administered intravenously or intraperitoneally, is a valid test substance for the presence or absence of a blood – brain barrier[3].

Intravenous trypan blue does not stain the adult brain[3], indicating the presence of a blood – brain barrier. On the other hand, intravenous trypan blue stains the brain in several new-born animals, indicating the absence of such a barrier[4]. The brain of the new-born mouse has not yet developed a blood – brain barrier and hence stains with trypan blue[5]. Periodic acid – Schiff staining of paraffin sections of the brains of neonatal mice reveals that the ground substance is not yet present in these forms. The brain of the new-born guinea pig already has a blood – brain barrier[4] and, like the adult, does not stain with trypan blue[6]. It has been shown that the ground substance of the guinea pig brain is present already in the fœtus at 45 days of gestation, and assumes proportions similar to the adult at 50 days gestation age[7]. Thus, the absence or presence of a blood – brain barrier as tested by the ability of the brains of animals to stain or not to stain with intravenous trypan blue appears to be related to the absence or presence of the ground substance of the central nervous system.

To test this hypothesis further, experiments were performed on the brains of rats. Hot-stab wounds of the brains of adult rats allow the brain to be stained by intraperitoneal trypan blue[8], thus implying a breakdown of the blood – brain barrier[3]. The stain is most intense after operation and until three days after injury, after which it gradually fades and is essentially absent ten days after operation[8]. Stab wounds with a hot needle were made in the brains of adult rats. After one to thirty days, the animals were killed and sections through the wound area were stained by the periodic acid – Schiff technique. After

a stab wound of the brain, an extensive area of brain surrounding the wound is negative to the periodic acid – Schiff test. This condition lasts for three days. After three days, the negative area around the wound begins to diminish in extent. This continues until ten days after the operation, by which time it has disappeared. After such brain wounds, the ground substance disappears, begins to be re-elaborated starting at the third day, and gradually increases in amount until its regeneration is about complete by the tenth day. Thus after brain wounds, the breakdown and reconstitution of the blood – brain barrier, as tested by intraperitoneal trypan blue staining, conforms to the same schedule as the dissolution and re-elaboration of the ground substance.

The site of the blood – brain barrier has been said to reside in the cerebral capillaries, in the capillary endothelium, or in the pia-glial membrane. From the results of the present experiments, it seems that the ground substance of the central nervous system contributes to the blood – brain barrier and is a substance which prevents the staining of the adult normal brain by intravenous or intraperitoneal trypan blue.

These experiments will be reported in detail shortly. This investigation was supported in part by research grant *B*-341 from the Institute of Neurological Diseases and Blindness of the National Institutes of Health, U.S. Public Health Service.

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[1] Hess, A., *J. Comp. Neurol.*, **98**, 69 (1953).
[2] Goldmann, E. E., "Vitalfärbung am Zentralnervensystem" (Georg Reimer, Berlin, 1913).
[3] King, L. S., *Arch. Neurol. and Psychiat.*, **41**, 51 (1939).
[4] Stern, L., and Peyrot, R., *C.R. Soc. de Biol.*, **96**, 1124 (1927).
[5] Behnsen, G., *Z. Zellforsch. u. mikr. Anat.*, **4**, 515 (1927).
[6] Broman, T., *Acta Psychiat. Neurol.*, **16**, 1 (1941).
[7] Hess, A., *J. Comp. Neurol.* (in the press).
[8] Macklin, C. G., and Macklin, M. T., *Arch. Neurol. and Psychiat.*, **3**, 353 (1920).

Effect of Methylcholanthrene on Ovaries of Mice

Although a great deal of work has been done on the carcinogenic action of methylcholanthrene, its effects on specific organs and tissue systems have not been completely investigated. Among the methods employed are: skin-painting, subcutaneous injection, intra-peritoneal administration as well as injection into the amniotic fluid of mice. The findings reported here are based on observations by another method which has been employed as part of an investigation for determining the strain specificity of certain endocrine organs of mice of the C_{57} (black), the Strong *A* and the C_3H (Bar) strains of mice. The results which were obtained are striking enough to deserve wider notice even at this stage.

Female mice of the three strains about two months of age were operated upon under anæsthesia and the ovaries exposed. Each ovary was gently lifted up with a pair of forceps and painted with a 0·25 per cent benzene solution of methylcholanthrene with a single stroke of a camel hair brush. The ovaries were then dropped back in place and the abdominal wound sutured up. When the sutures healed, the animals were kept for mating with their respective litter-mate males.

It has been observed that an over-all hæmorrhagic effect is seen in the young of all the strains and in particular the C_3H (Bar) strain. Localized hæmorrhagic areas are seen in all and particularly in the C_{57} strain. These areas are almost always on the upper lip, the back between the scapulæ, the shoulders, and the legs especially the digits. Blood clots have been observed in the C_{57} (black) and the Strong *A* strains. These are at the tip of the nose, the chin, on the digits and in some cases at the second joint of the limbs. One or several may be present in a single animal. In the Strong *A* strain, one young with a club foot was observed. This animal lived to be eleven days old, at which time the mother destroyed it. Histological sections have shown that the hæmorrhage is not in any particular region but diffused throughout the connective tissue and muscles. Table 1 gives a summary of the reactions seen in the different strains.

From the observations available so far, it seems as though the ova of each strain respond differently to methylcholanthrene. The effect on the C_{57} (black) seems to be most drastic, while in the Strong *A* it is least lethal. On the C_3H Bar it appears to be intermediate in action. It would seem as though the effect on the ova persists, for the reaction is obvious not only in the first litter but also in subsequent litters as well.

When the investigations in progress are completed, full details will be published.

This communication is published by permission of of Dr. V. R. Khanolkar, director, Indian Cancer Research Centre, under whose guidance the work is being done.

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Morphine Antagonists

In an earlier communication[1], we described the antagonistic action of tetrahydroaminacrin and 2-4 diamino 5 phenyl thiazole towards the depressant effects of morphine. It was shown there that these antagonists did not affect the analgesic properties of morphine on rats.

Table 1

Strain of mice	No. of breeders	No. of litters	No. of young	Total No. of young alive	Total No. of young dead	Still-born young	Young with generalized hæmorrhage	Young with localized hæmorrhage	Young with blood clots
A (Strong)	4	11	62	40*	12	—	4	2	6
C_3H (Bar)	3	3	19	4	15	—	11	4	—
C_{57} (black)	4	8	40	3	37	5†	2	24	6

* One of these had a club foot.
† All five belonged to the same litter. The mother developed a uterine tumour

Since then we have had an opportunity of confirming this remarkable differential antagonism on human beings. Five patients suffering intolerable pain in the terminal stages of carcinoma were the subjects of this investigation. They had been receiving incomplete relief from up to 3 gr. of morphine per day, given in divided doses at 2–4 hourly intervals. These patients were given as much as 1½ gr. of morphine in one injection, and the severe respiratory depression and narcosis which followed were relieved by an injection of up to 40 mgm. of 2-4 diamino 5 phenyl thiazole. The analgesic effect of the morphine was, however, unaffected, and the patients remained free from pain for twelve hours and longer.

The relief from the depressant effects of morphine was selectively graded. Respiratory depression was first relieved, followed by a lessening of the narcosis, as the dose of 2-4 diamino 5 phenyl thiazole was increased; large doses completely awakened the patient without lessening the analgesia, although the duration of relief was shortened.

We have been able to observe the above response daily in two cases for a period of ten weeks and in a further two cases for a period of six weeks. During this period there was no evidence of the development of any tolerance, either to morphine or 2-4 diamino 5 phenyl thiazole.

The thiazole derivative differed from N-allyl-*nor*-morphine in several respects. It did not provoke withdrawal symptoms in patients already receiving morphine and therefore is not a complete antagonist[3]. It had no disagreeable side-effects when given alone in doses five to ten times the therapeutic; but individual variation should always be anticipated. It does not antagonize the analgesic action of the morphine in therapeutic doses.

Both compounds are antagonists of 'Pethidine', 'Amidone' and 'Omnipon'. The full results will be published in a clinical journal[3].

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[1] Shaw, F. H., and Bentley, G., *Nature*, **169**, 712 (1952).
[2] Winter, C. A., *et al.*, *J. Pharm. and Exp. Ther.*, **111**, 152 (1954).
[3] Shulman, A., and Shaw, F. H., *Brit. Med. J.* (in the press).

Size of the Myosin Molecule

At present considerable confusion exists concerning the size of the myosin molecule. In a recent paper, Parrish and Mommaerts[1] reported a molecular weight of 650,000 and sedimentation-diffusion data which differ considerably from previous ones reported by various authors.

We would like to report briefly our findings, which set the molecular weight of myosin even lower than those of Parrish and Mommaerts. Using fresh myosin which had not been exposed to temperatures above 10° C. (see ref. 2), we find the diffusion coefficient $D^{w}_{20} = 1{\cdot}0 \times 10^{-7}$ (measured at 1° C. and extrapolated to zero concentration), in very good agreement with the value found by Parrish and Mommaerts[1], and considerably higher than those obtained by earlier workers. The sedimentation constant extrapolated to zero concentration and measured at approximately 4° C. gives $S^{w}_{20} = 6{\cdot}15 \times 10^{-13}$ (ref. 3). This figure is in agreement with 6·20 obtained also at low temperature by Miller *et al.*[4]. Using a value of 0·728 for the partial specific volume[1], the molecular weight is calculated to be about 500,000.

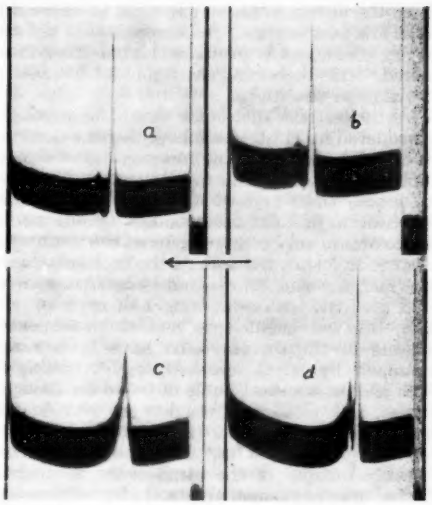

Fig. 1. 0·42 per cent myosin in 0·6 *M* potassium chloride, 0·005 *M* histidine buffer, pH 6·8, centrifuged at 59,780 r.p.m. under different conditions: (*a*) fresh myosin at 5·1° C., 129 min., $S(w, 20) = 4{\cdot}6$; (*b*) fresh myosin at 26·0° C., 81 min., $S(w, 20) = 5{\cdot}1$; (*c*) myosin incubated 2 hr. at 25° C. run at 28·7° C., 49 min., $S(w, 20) = 8{\cdot}2$; (*d*) myosin incubated 2 hr. at 25° C., run at 9·0° C., 81 min., $S(w, 20) = 4{\cdot}8$. The arrow shows the direction of sedimentation

In addition to confirming the observations of Mommaerts[1] and Blum and Morales[5] that the apparent sedimentation constant of myosin depends somewhat on temperature (see some of our results in Table 1), we found that more profound changes occur in the myosin molecule when left standing at temperatures of 25–30° C. for several hours. Fresh myosin centrifuged at 5° or 25° C. shows a typical sharp sedimenting boundary with a sedimentation constant of about 5×10^{-13} (Fig. 1, *a* and *b*). If left standing at room temperature for two hours, the nature of the boundary changes and the sedimentation constant increases to $8{\cdot}2 \times 10^{-13}$ (Fig. 1, *c*). At this stage, however, the change is apparently reversible, for when centrifuged in the cold the more symmetrical sharp boundary reappears and $S = 4{\cdot}8 \times 10^{-13}$ (Fig. 1, *d*). Longer incubation apparently produces further and irreversible changes. These changes in the hydrodynamic properties of myosin with temperature may be peculiar to myosin and related to its role as the contractile protein of muscle; but in any event they seem to be the explanation of the divergent values reported in the literature. Whether the change with increased temperature represents a change of shape or aggregation or both cannot yet be stated.

Table 1. Effect of Temperature on Apparent Sedimentation Constant of Myosin

0·19 per cent myosin in 0·6 *M* potassium chloride

Temperature of run (av.) (in ° C.)	$S(w, 20) \times 10^{13}$
5·5	5·1
11·0	5·3
25·6	5·5

Since the changes can be expected to occur slowly even at low temperature, one suspects that the actual diffusion coefficient is probably higher than that we obtained, and, therefore, the figure of 500,000 may be considered too high.

Nevertheless, the molecular weight of myosin can be considered as established from the size determinations performed on the meromyosins—the split products of myosin. The meromyosins appear to be more stable than myosin and readily amenable to sedimentation and diffusion studies. Since we found that the amino-acid compositions of the meromyosins add up to myosin[6], the sum of the molecular weights of the meromyosins (two *L*- and one *H*-meromyosin) should give the molecular weight of myosin.

The diffusion coefficients and the sedimentation constants of the meromyosins have been carefully determined by A. G. Szent-Györgyi[7]. With these results and an assumed value of 0·748 for the specific volumes, the molecular weights of 96,000 (for *L*-meromyosin) and 232,000 (for *H*-meromyosin) were obtained. Gergely *et al.*[8] have published recently molecular weights of the same order of magnitude for the meromyosins obtained by chymotryptic digestion. The sum of the meromyosins (two *L* and one *H*) gives a molecular weight of 424,000 for myosin. This figure is about half that obtained by Weber and one-fourth of that obtained by Snellman. It is possible that the previous investigators were measuring the molecular weight of some stable stepwise aggregate of myosin probably isolated as such from the muscle tissue.

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[1] Parrish, R. G., and Mommaerts, W. F. H. M., *J. Biol. Chem.*, **209**, 901 (1954).
[2] Kessler, V., and Spicer, S. S., *Biochim. et Biophys. Acta*, **8**, 474 (1952).
[3] Laki, K., Spicer, S. S., and Carroll, W. R., *Nature*, **169**, 328 (1952).
[4] Miller, G. L., Golden, R. H., Eibelman, E. S., and Miller, E. E., *Arch. Biochem. and Biophys.*, **41**, 125 (1952).
[5] Blum, J. J., and Morales, M. F., *Arch. Biochem. and Biophys.*, **43**, 208 (1953).
[6] Kominz, D. R., Hough, A., Symonds, P., and Laki, K., *Arch. Biochem. and Biophys.*, **50**, 148 (1954).
[7] Szent-Györgyi, A. G., *Arch. Biochem. and Biophys.*, **42**, 305 (1953).
[8] Gergely, J., Gouvea, M. A., and Karibian, D., *J. Biol. Chem.*, [212, 165 (1955)].

Visual Pigments and Vitamins A of the Clawed Toad, *Xenopus laevis*

Dartnall[1] has recently reported extracting what he describes as a new visual pigment from the retina of the South African clawed toad, *Xenopus laevis*. It is a purple substance, which in Dartnall's preparations has an absorption maximum ($\lambda_{max.}$) at 514–516 mμ. Its difference spectrum—the difference in absorption between it and the products of its bleaching—has $\lambda_{max.}$ 521 mμ at *p*H about 8·6. Dartnall argues, largely on the basis of analogies with the behaviour of other types of preparation, that the absorption maximum of the *Xenopus* pigment in reality lies at 519 mμ. I see no reason, however, for rejecting his measurements, which are as stated. They show the properties of the *Xenopus* pigment to be intermediate between those of rhodopsin and porphyropsin. The absorption spectrum of rhodopsin ordinarily has $\lambda_{max.}$ 500 ± 2 mμ, that of porphyropsin $\lambda_{max.}$ 522 ± 2 mμ[2]. The *Xenopus* pigment, with $\lambda_{max.}$ about 515 mμ, might on this basis consist of a mixture of about 70 per cent porphyropsin and 30 per cent rhodopsin. Its difference spectrum is similarly intermediate: $\lambda_{max.}$ of rhodopsin lies at about 500–502 mμ, that of porphyropsin at about 525–530 mμ in such mildly alkaline solutions as Dartnall employed; so that again the *Xenopus* pigment, with difference $\lambda_{max.}$ 521 mμ, appears to be a mixture of about two-thirds to four-fifths porphyropsin with one-third to one-fifth rhodopsin.

Such a mixture of pigments should be most easily analysed through the fact that, in retinæ exposed to light, rhodopsin bleaches to yield vitamin A_1, porphyropsin to yield vitamin A_2. The vitamins A are readily identified by the blue products which they form on mixing with antimony chloride reagent, possessing characteristic absorption bands, vitamin A_1 at about 620 mμ, vitamin A_2 at about 690 mμ.

Fig. 1 shows the absorption spectra of antimony chloride tests with extracts of *Xenopus* retinæ, pigment layers (pigment epithelia + choroids), and livers. Twelve male animals which had been kept without food for three weeks were dark-adapted, and the eyes removed under red light. The retinæ were separated from the pigment layers, and were bleached by exposure to moderate light for 1·5 hr. This treatment degrades the visual systems to the vitamins A. The retinæ and pigment layers were digested separately in 6 per cent potassium hydroxide in methanol. This mixture was diluted with water and extracted thoroughly with petroleum ether. The extracts, transferred to chloroform, were mixed with saturated antimony chloride in chloroform, in absorption cells already placed in a Cary recording spectrophotometer, and the absorption spectra of the resulting products were recorded immediately. These are shown in Fig. 1.

Livers from six toads were minced, ground with anhydrous sodium sulphate until powdery, and extracted with petroleum ether. The yellow extract was saponified in 6 per cent potassium hydroxide in methanol, and transferred to hexane. It contained a yellow carotenoid, epiphasic in partition between petroleum ether and 90 per cent methanol, and possessing absorption bands in hexane at 447·5 and 475 mμ. In these properties it resembles α-carotene ($\lambda_{max.}$ 447·5, 478 mμ). The liver extract also contained a mixture of vitamins A. It possessed an absorption band in the near ultra-violet at 333 mμ in chloroform (vitamin A_1, 328 mμ; A_2, 350 mμ); and yielded with antimony chloride the spectrum shown in Fig. 1, displaying the bands near 620 and 690 mμ characteristic of both vitamins.

Fig. 1 shows that the bleached *Xenopus* retina contains predominantly vitamin A_2. The same is true of the pigment layers. A broad elevation of spectrum in the region of 620 mμ in both cases represents a small admixture of vitamin A_1. The livers also contain both vitamins A, but in reverse proportions, vitamin A_1 predominating.

The proportions of vitamins A_1 and A_2 in such mixtures are readily assessed by solving the simultaneous equations:

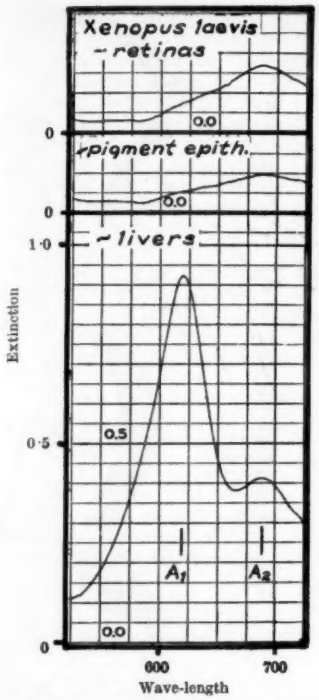

Fig. 1. Absorption spectra of antimony chloride tests with saponified extracts of eye tissues and livers of the clawed toad, *Xenopus laevis*. The spectra were recorded automatically, immediately after mixing the reagents. An absorption maximum at about 620 mμ identifies vitamin A_1, one at about 690 mμ vitamin A_2. The spectra show that the bleached retina and the pigment layers—pigment epithelium and choroid—contain vitamin A_2 mixed with a little A_1; whereas the livers contain predominantly vitamin A_1

$$x = \frac{2{\cdot}56\,k_{620} - k_{690}}{2{\cdot}48}; \quad y = k_{690} - 0{\cdot}08\,x,$$

in which k_{620} and k_{690} are the extinctions measured at these wave-lengths, x is the extinction at 620 mμ specifically due to vitamin A_1, and y the extinction at 690 mμ specifically due to vitamin A_2 [3]. x and y can be converted into μgm./ml. in the test solution by dividing x by 0·44 and y by 0·41 (since E (1 per cent, 1 cm.) in the antimony chloride test is 4400 for vitamin A_1, and 4100 for A_2 [4]). In this way we find the proportions of the vitamins A in *Xenopus* tissues to be approximately as follows: retinæ, $A_1/A_2 = 5/95$; pigment layers, $A_1/A_2 = 12/88$; livers, $A_1/A_2 = 68/32$. About 0·06 μgm. of vitamin A_2 was obtained from each *Xenopus* retina, and about half as much from the pigment layers of each eye.

We may conclude that the principal visual pigment of the *Xenopus* retina is porphyropsin. In our animals —judging from the amount of vitamin A_1 present— this seems to have been accompanied by a very small proportion of rhodopsin. Dartnall's extracts, interpreted in these terms, appear to have contained a higher proportion of rhodopsin, owing possibly to his having fed his animals with raw liver, a material notoriously rich in vitamin A_1. The possibility must also be conceded, though a little unlikely, that $\lambda_{max.}$ for *Xenopus* porphyropsin lies at shorter wave-lengths than that for other porphyropsins so far investigated. Even if it lay at the short wave-length limit for known porphyropsins, little discrepancy would remain between the proportions of rhodopsin and porphyropsin estimated on the basis of Dartnall's measurements and our own. It should be added that if Dartnall is correct in his belief that the true $\lambda_{max.}$ of the *Xenopus* pigment lies at 519 mμ, no discrepancy at all remains between his measurements and ours.

Dartnall tested his extracts for the presence of a mixture of pigments, by inquiring whether partial bleaching in various regions of the spectrum would produce differential effects. He concluded that he had to deal with a single pigment. To this it must be said, however, that he had over-estimated the differences to be expected, in the belief that the $\lambda_{max.}$ of porphyropsin is near 533 mμ, a belief based upon indirect considerations[5]. All direct measurements made so far upon adequate preparations of porphyropsin give $\lambda_{max.}$ at 522 ± 2 mμ (cf. ref. 6). The absorption spectra of rhodopsin and porphyropsin therefore overlap very widely, and only the most searching measurements would resolve such mixtures as here indicated. It is possible that slight bleaching in red light as compared with white light would reveal a difference; unfortunately Dartnall, though he apparently made such measurements, has not shown the results in a form that permits accurate discrimination.

Xenopus is not the only animal that presents such a mixture of visual pigments and vitamins A in the eye and liver as we have described. The anadromous sea lamprey, *Petromyzon*[7], and the anadromous chinook salmon and brook trout[3,8] present much the same pattern. I have found this distribution also among tailed Amphibia in the permanently larval mudpuppy, *Necturus*[9]; and among tailless Amphibia in the tadpole of the bullfrog, *Rana catesbiana*, in which the distribution of visual pigments and vitamins A is almost identical with that in *Xenopus*[9].

Porphyropsin is associated characteristically with vertebrates which dwell in, or more specifically which originate in, fresh water. It is this association which we pursue through the anadromous lamprey, the freshwater fishes, the adult water-phase newt, and the larval amphibia already cited[9]. The special significance, therefore, of Dartnall's observation is not the discovery of a new visual pigment, but the first demonstration of porphyropsin in an adult anuran. It is particularly significant that this should involve *Xenopus*, a member of the peculiar group *Aglossa*, possessing neither tongue nor teeth, and a purely aquatic animal. Here, as in other examples, the genetic factors which govern the freshwater habit have brought the use of porphyropsin in their train.

(This research was supported in part by funds from the Rockefeller Foundation and the Office of Naval Research.)

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[1] Dartnall, H. J. A., *J. Physiol.*, **125**, 25 (1954).
[2] Wald, G., *J. Gen. Physiol.*, **21**, 795 (1937–38); **22**, 775 (1938–39).
[3] Wald, G., *J. Gen. Physiol.*, **22**, 391 (1938–39)
[4] Cawley, J. D., Robeson, C. D., Weisler, L., Shantz, E. M., Embree, N. D., and Baxter, J. G., *Science*, **107**, 346 (1948). Shantz, E. M., *Science*, **108**, 417 (1948).
[5] Dartnall, H. J. A., *J. Physiol.*, **116**, 257 (1952).
[6] Wald, G., *Ann. Rev. Biochem.*, **22**, 497 (1953).
[7] Wald, G., *J. Gen. Physiol.*, **25**, 331 (1941–42).
[8] Wald, G., *J. Gen. Physiol.*, **25**, 235 (1941–42).
[9] Wald, G., Harvey Lectures, **41**, 117 (1945–46); "Biochemical Evolution", in "Modern Trends in Physiology and Biochemistry", 337 (E. S. G. Barron, editor) (Academic Press, New York, 1952).

A New Structure observed in *Trypanosoma evansi* (Indian Strain)

Recent investigations show the existence of a new structure in the Indian strain of *Trypanosoma evansi*, the causal agent of the virulent disease 'surra' in domestic and other animals.

Trypanosoma evansi was maintained *in vivo* in white rats and transferred every few days whenever the infection was too heavy in one animal. These specimens after suitable treatment were studied with the light, phase-contrast and electron microscopes. Stained films for photomicrography were made by making a smear of infected blood on a glass slide and staining with J.S.B.[1] stain (Fig. 1). For phase-contrast microscopy, a drop of infected blood was mixed with physiological saline on a glass slide; a cover glass was superposed and pressed in order to produce a very thin film of suspension. When the movement of the flagellates ceased, phase-contrast micrographs were made with a Spencer dark *M* phase objective (Fig. 2).

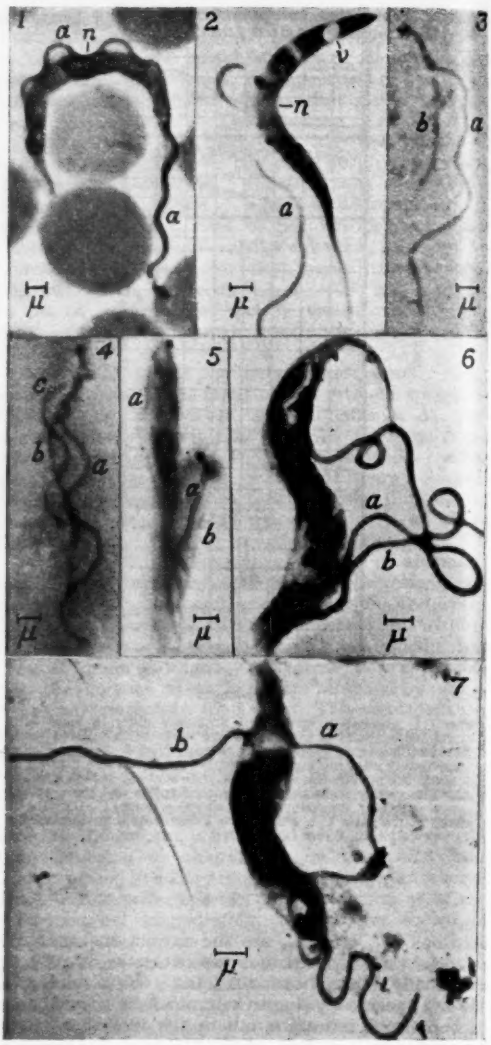
Trypanosomes are known to be uniflagellate organisms. In the stained photomicrograph (Fig. 1), the major part of the flagellum (*a*) is found to form the bordering filament of the undulating membrane, and only a small portion of this structure extends beyond the body as free flagellum. This flagellum (*a*) is also clearly visible in the phase-contrast micrograph of the unstained parasites (Fig. 2). In the latter the nuclear site (*n*) is seen to be lighter than the rest of the cell, with the exception of the vacuole (*v*). This shows that the nuclear site has a smaller optical path compared to the rest of the cell, a fact which has also been noticed in the case of *Leishmania donovani*[2].

For further detailed study, the trypanosomes were separated and concentrated from infected blood by centrifugation with normal saline. The concentrated specimens were then treated in the following three methods. In the first method, a portion of the concentrate was suspended in distilled water for 30 min. at room temperature. This water-treated material was then fixed in Schaudin's fluid, stained with Heidenhain's iron hæmatoxylin (long method) and then micrographed (Figs. 3, 4). A second part of the concentrate was crushed between two glass slides by the application of pressure and afterwards stained with J.S.B. stain (Fig. 5).

In Figs. 3 and 4 showing specimens treated with distilled water, the whole of the protoplasmic material has disintegrated and a two-flagella structure is clearly visible (Fig. 3, *a* and *b*). One of the flagella observed (*a*) is the usual flagellum which originates from the blepharoplast and is attached to the body surface (cf. Figs. 1 and 2). The second flagellum (*b*) is also found to originate from the region of the blepharoplast. This possibly forms the inner border of the undulating membrane and is usually missed in the stained photomicrographs. This second structure (*b*) will be referred to as 'costa' in analogy with a similar organelle found at the base of the undulating membrane of trichomonad flagellates. When the organism is in the dividing stage (Fig. 4), in addition to the two flagella (*a* and *b*) already described a third one (*c*) is also noticeable. In the photomicrograph obtained from crushed and stained specimens (Fig. 5) the two flagella (*a* and *b*) are again seen.

A third part of the concentrated specimen was fixed in 1 per cent formalin for examination with the electron microscope. The organisms were so dense, however, that no internal structure was visible. In order to make the specimens more transparent to the electron beam, they were subjected to hydrolysis in *N* hydrochloric acid at 60° C., a treatment which has proved very suitable for the study of other protozoal organisms, namely, *Leishmania donovani*[2], and *Plasmodium burghei*[3].

The electron micrographs of the hydrolysed specimens (Figs. 6 and 7) again show the existence of the two flagella (*a* and *b*). Both flagella are found to



Micrographs of *Trypanosoma evansi* under different conditions. (*n*) Nucleus, (*v*) vacuole, (*a*) flagellum usually observed and (*b*) the second flagellum.

Fig. 1. Photomicrograph after J.S.B. stain. Fig. 2. Dark phase-contrast micrograph of a living specimen showing that the nuclear site is lighter than the rest of the cell. Fig. 3. Specimen treated with distilled water, showing the common origin of the two flagella. Fig. 4. Specimen treated with distilled water in a dividing stage; in addition to the two flagella (*a*) and (*b*) a third one (*c*) is also noticeable. Fig. 5. A crushed specimen. Figs. 6 and 7. Electron micrographs. Notice two flagella (*a*) and (*b*) originating from the same place and uneven electron scattering power in different parts of the cell

originate from the same place; the longer one (*a*) forming the bordering flagellum of the undulating membrane is still intact in some parts in both figures. Close observation of Fig. 6 reveals the presence of fine fibrils attached to the surface of the two flagella. This is highly suggestive of the fraying of the protoplasmic sheath in the process of hydrolysis. However, during this work, the presence of fine fibrils composing the flagellum was not observed, as reported by Kraneveld *et al.*[4].

Thus the photomicrographs of water-treated and crushed specimens, as well as the electron micrographs of the hydrolysed specimens, definitely show that *Trypanosoma evansi* (Indian strain) possesses a structure at the inner border of the undulating membrane which can very well be compared with the 'costa' or basal fibre of the flagellates belonging to the family Trichomonadidae.

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[1] Singh, J., and Bhattacharya, L. M., *Ind. Med. Gaz.*, **79**, 102 (1944).
[2] Das Gupta, N. N., Guha, A., and De, M. L., *Exp. Cell Res.*, **6**, 353 (1954).
[3] Dutta, B. N., Das Gupta, N. N., De, M. L., Guha, A., and Nandi, S., *Science*, **120**, 428 (1954).
[4] Kraneveld, F. G., Hauwink, A. L., and Keidel, H. J. W., *Proc. Kon. Ned. Akad. Wetensch.*, C, **54**, 393 (1951).

Life-cycle of *Porphyra capensis* Kütz.

Although germination of the spores of *Porphyra* has been observed under cultural conditions by a number of workers[1,2], the complete life-cycle of this plant, from the germination of the carpospore to the re-establishment of the leafy thallus, has never been conclusively demonstrated. The most recent work has been done with *P. umbilicalis* (L.) Kütz. by Drew[1,3], who has shown that the filaments produced by the carpospores of this species will penetrate shell and afterwards form growths which appear to be identical with those of *Conchocelis rosea* Batters[4]. Sporangia-like bodies (termed 'fertile cell rows' by Drew) developed in the cultures; but no spores were formed from these. Evidence of spore formation was obtained, however, from some similar growths occurring naturally in the scales of the barnacle *Pollicipes cornucopia* Leach[5].

No previous investigations have been carried out on the life-history of the South African species *Porphyra capensis* Kütz. In 1952, therefore, an attempt was made to germinate the carpospores of this species in culture. The spores were placed on glass slides and on pieces of egg shell, and in both cases growths were obtained which were similar to those recorded by Drew for *P. umbilicalis*[3]. Filaments from the spores placed on egg shell penetrated the shell and formed much-branched extensive growths, but the plants did not develop further. There was no convincing evidence of the formation of any bodies of a reproductive nature.

In February 1954, a further attempt was made. Development of filamentous growths from carpospores

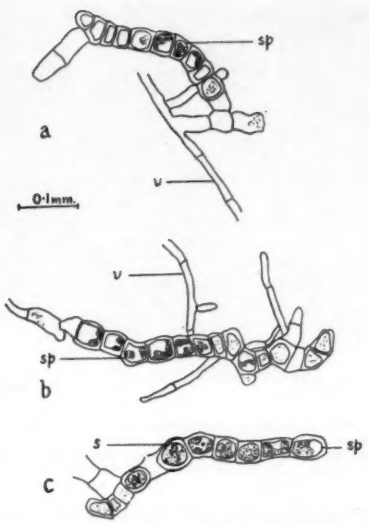

Fig. 1. Parts of plants of filamentous phase of *Porphyra capensis* Kütz from the surface of egg shell 41 days after first emersion of the shell. Culture eight months old. (*a*) and (*b*), branched rows of sporangia (*sp*) and vegetative branches (*v*); (*c*) early stage in spore formation (*s*)

and their penetration of the shells proceeded as before, but this time a large number of sporangial structures were produced which closely resembled those described by Drew as 'fertile cell rows' (Fig. 1, *a*, *b*).

The cultures were maintained, and at the beginning of August a number of young leafy plants of the adult phase of *Porphyra* were seen to be growing attached to the bottom of the glass flask in which the shells were kept. Considerable care had been taken to keep these cultures free, so far as possible, from outside infection. The shells and apparatus employed were sterilized and only boiled, filtered sea-water was used. The cultures were aerated with air passed through a cotton-wool filter. The shells were periodically exposed to the air for periods of about an hour, so that to this extent the cultures were not under sterile conditions. However, it should be noted that leafy plants developed in the flask and not on the shells. Therefore, although the evidence was not conclusive, it would seem reasonably certain, in view of the precautions taken, that the young leafy plants had arisen from the filamentous plants growing in the same culture. Recently, in a second similar culture, germinating spores were observed in some of the sporangia, each sporangium producing one spore (Fig. 1 *c*). Other spores were observed to germinate after liberation from sporangia (Fig. 2).

Young leafy plants were produced, some of which were within, and others outside, the sporangia (Fig. 3). The leafy plants previously observed to be attached to the bottom of the flask were at a more

Fig. 2. Germinating spore of leafy phase of *Porphyra capensis* Kütz. Sporangia of filamentous phase can also be seen. Photographed in the living condition

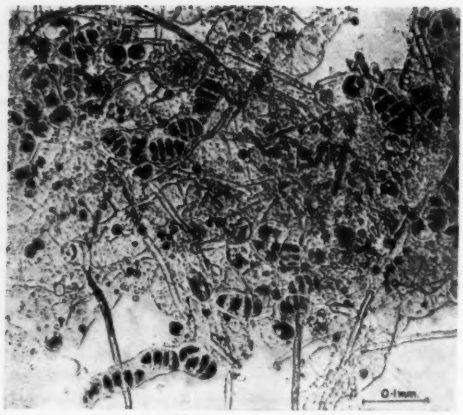

Fig. 3. Parts of plants of filamentous phase of *Porphyra capensis* Kütz. from the surface of egg shell, showing rows of sporangia and vegetative branches with spores and young plants of the leafy phase. Photographed in the living condition

advanced stage of development than those shown in Fig. 3.

The exact mode of liberation of the spores is uncertain, although in some cases there is breakdown of the transverse walls between individual sporangia as described by Drew for the material from *Pollicipes cornucopia*[5].

A full account of this work is to be published later. Thanks are due to the South African Council for Scientific and Industrial Research, the financial support of which has made possible the continuance of this investigation, and to Prof. Wm. Edwyn Isaac for general guidance of the research.

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[1] Drew, K. M., *Nature*, **164**, 748 (1949).
[2] Grubb, V. M., *Rev. Algol.*, **1**, 223 (1924).
[3] Drew, K. M., *Ann. Bot.*, N.S., **18**, 183 (1954).
[4] Batters, E. A. L., *Phycol. Mem.*, **1**, 25 (1892).
[5] Drew, K. M., and Richards, K. S., *J. Linn. Soc.*, **55**, 84 (1953).

Positional Pseudo-Alleles in Diploid Potatoes

The anthocyanins of diploid cultivated potatoes ($2n = 24$) are controlled by at least two independent loci of which one, *P*, is epistatic to the other *R*[1]. Three closely linked loci, *B*, *I* and *F*, on another chromosome, are concerned with the distribution of pigment on the body of the plant. Locus *I* in its homozygous recessive phase *ii* is epistatic to the two colour loci and leads to the absence of pigment in the tuber, to which organ its main action is localized. Locus *F* governs the contrast between flecked and self-coloured flowers. The former are homozygous recessives, *ff*; they are mainly white, but show dashes of colour on and around the vascular 'star' which is characteristic of the corolla. Loci *I* and *F* have shown a recombination value of $1{\cdot}98 \pm 0{\cdot}62$ per cent.

Seeds may be spotted owing to the presence of pigment on the cotyledonary node of the embryo and which shows through the testa. On the haulm, opposite the axil of each leaf, there may be a nodal band of pigment on the abaxial surface. The floral abscission layer may be coloured with anthocyanin or green. In white tubers, the eyebrow may be coloured or uncoloured, but the difference is masked in self-coloured tubers. Apparently these manifold expressions of the distribution of pigment may occur separately or together in nearly all combinations. They are on homologous parts of the plant body and seem to be interpreted most satisfactorily by assuming a series of alleles, $B^d > B^e > B^b > B^a > b$, in order of dominance. No estimate is given of the close linkage between loci *B* and *I* because satisfactory parents for the appropriate crosses are not yet available.

Table 1. Phenotypic Effects of Alleles at Locus *B*

Allele	Pigment			
	Spot on embryo	Nodal band	Floral abscission	Tuber eyebrow
b	−	−	−	−
B^a	−	−	+	−
B^b	−	−	+	+
B^e	+	−	+	+
B^d	+	+	+	+

C.P.C. 827[2] $\frac{B^eiF}{b\,IF}$ was crossed with *C.P.C.* 1776 $\frac{bif}{bif}$ and the expected two classes $\frac{B^eiF}{bif}$ and $\frac{bIf}{bif}$ were obtained. In addition, two recombinants occurred: (*a*) $\frac{B^eif}{bif}$ and (*b*) $\frac{B^eIf}{bif}$.

One of these, namely (*a*), a plant with white tubers and red eyebrows and flecked flowers, raised from a non-spotted seed, must have resulted from a cross-over between loci *I* and *F* which, as mentioned above, have $1{\cdot}68 \pm 0{\cdot}62$ per cent recombination. That this individual is heterozygous B^eb may be inferred from the presence of a coloured eyebrow on the tuber.

The other recombinant, namely (*b*), is a plant with blue tubers and flecked flowers raised from a spotted seed. That it is indeed heterozygous B^eb and not a misclassified non-spot is shown by its breeding behaviour in a backcross to *C.P.C.* 1776. Expectation is a 1 : 3 ratio of spotted to non-spotted seeds, because the spotting effect of locus *B* is expressed only in the presence of allele *P*, for which *C.P.C.* 1766 is homozygous recessive. Out of 255 seeds, 60 had purple spots and 195 were without spots (χ^2 to a 1 : 3 ratio is 0·29 for 1 d.f.; $P = 0{\cdot}60$).

The occurrence of recombinant (*b*) shows that the three loci are arranged in the chromosome in the sequence *B*—*I*—*F*.

A notable feature of the recombinant $\frac{B^eIf}{bif}$ is that nodal bands of pigment occur on the haulm opposite the axils of all leaves. Thus it appears that when allele B^e is brought into contiguity with dominant allele *I*, the characteristic banding effect of allele B^d is developed (Table 1). Allele B^d occurs in only one clone of our collection, namely, *C.P.C.* 2211, of which the genotype is B^dIF. Here also alleles B^d and dominant *I* are adjacent; and until they are separated by recombination it cannot be decided whether B^d is merely the compound B^eI or an allele in its own right.

This example is similar to those interactions in *Drosophila*[2] in which the heterozygotes represented as $+_1+_2/m_1m_2$ and $+_1m_2/m_1+_2$ (m designates the mutant form) are not equivalent in action. Like the A^b locus[4] in maize, physically distinct units function co-operatively in the determination of an effect.

The observation is of particular interest owing to the implication that the proximity of these loci concerned with distribution of pigment is not fortuitous.

A fuller account of this work will be published elsewhere with my colleague D. H. Long, who recorded this progeny at the Agricultural Research Council's Potato Genetics Research Station in Cambridge.

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[1] Dodds, K. S., and Long, D. H., *J. Genet.* (in the press).
[2] Hawkes, J. G., *I.A.B. Bull.*, pp. 142 (1944).
[3] Lewis, E. B., *Genetics*, **33**, 113 (1948). Green, M. M., and Green, K. C., *Proc. U.S. Nat. Acad. Sci.*, **35**, 586 (1949).
[4] Laughnan, J. R., *Proc. U.S. Nat. Acad. Sci.*, **35**, 167 (1949).

Hereditary (Seed-borne) Symbiosis in *Ardisia humilis* Vahl.

STEVENSON[1] recorded bacterial symbiosis in some New Zealand plants, Singh[2] noticed bacteria in stems, leaves and flowers of a number of angiospermic plants in South India, and Heimbeck[3] recently reported the occurrence of *L* forms of bacteria in wilting pea, which are filtrable through membranes that retain the smallest bacteria.

In *Ardisia humilis* (Myrsinaceae) growing in the Carmichael Medical College garden, schizogenous glands are found in leaves, stems, roots, floral envelopes (calyx and corolla), stamens, styles and in endosperms of seeds. *B.* type *L* forms of bacteria are found in large numbers close to these glands, and a pinkish colour is very noticeable in young leaves (especially at their margins), sepals, petals, anthers, carpels and seeds. Roots have conspicuous irregular nodular swellings due to infection by bacteria, and leaves, sepals and petals bear a large number of glands. The plants are perfectly healthy, they have grown for more than twenty years in the College garden and normally bear abundant lilac-coloured flowers and fruits. In fact, *B.* type *L* forms of bacteria are found in every part of the plant, especially in growing regions and organs. Bacteria were aseptically isolated from leaves and roots and were grown in pure culture in nutrient agar, malt-agar and in liquid malt, when a large number of *L* bodies similar to those photographed by Heimbeck (Fig. Nos. 7–11)[3] were found along with the bacteria in the form of small granules. The *L* forms were found to grow in small colonies without exuding mucilage or slime, their colonies forming each a dark central portion surrounded by lighter peripheral zone. Such forms are regarded by Kleineberger-Nobel[4] as forms intermediate between virus and bacteria.

Pohjakallio *et al.*[5] remark that micro-organisms (in their case, one *Pseudomonas* sp.) may antibiotically limit the damage caused by clover-rot fungus (*Sclerotinia trifoliorum* Erikss.) to clover, *Trifolium pratense*.

The red colour from leaves, roots, anthers, etc., can be extracted easily with absolute alcohol. Absorption spectra of this colour and its chemical characters are being studied with the view of finding out if it contains hæmin and also if this colour is the metabolic product of *L* type organisms. The results of this study will be described in due course.

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[1] Stevenson, G. B., *Ann. Bot.*, N.S., **17**, 343 (1953).
[2] Singh, T. C. N., Ind. Sci. Congress Proc., Lucknow (1953); also Ind. Sci. Congress Proc. (1950 and 1951).
[3] Heimbeck, L. S., "On the Etiology of Brown Roots, Yellowing and Wilt due to 'B. type L. Forms' of Bacteria, with special reference to Pea-Wilt" (Levanger, Norway, 1954).
[4] Kleineberger-Nobel, E., *Biol. Rev.*, **29**, 154 (1954).
[5] Pohjakallio, O., Salonen, A., and Relander, E., *Acta Agric Scand.*, **3**, 53 (1953).

Blood Supply of Mystacial Vibrissæ

CURRENT interest in the blood supply to the skin and hair follicles of the sheep[1,2] prompts description of some recent investigations into the blood supply to the mystacial vibrissæ of the cat and rat. The animals were killed with ether and amyl nitrite, or intraperitoneal 'Nembutal', and a polythene cannula introduced into either the common carotid artery or jugular vein. Blood was washed out with warm normal saline containing sodium nitrite or with 'Priscol', a sympathetic blocking agent. A warm 2 per cent aqueous solution of soluble Berlin blue was the best of the injection masses used, due to its small particle-size and low viscosity. Techniques dependent on the presence of hæmoglobin did not reveal the fine vessels traversing the trabeculæ because they were obscured by blood in the sinuses, while constricted vessels empty of blood were overlooked.

Observation on injected mystacial pads fixed either in 80 per cent alcohol and cleared by the method of Spalteholz, or in formal–saline and sectioned on the freezing microtome at 100–150 μ, show a main artery approaching the side of each follicle. This gives branches to the striated muscles of adjacent follicles, and to a capillary plexus between the necks of the follicles, and then accompanies the sensory nerve passing through the outer dermal sheath at an angle of about 45°. At the inner limit of the middle dermal sheath it divides into three branches (Fig. 1). The first, a fine vessel, turns sharply to the base of the follicle and contributes to a capillary network which extends to the hair matrix. A second, larger branch contributes to the capillary network of the middle region of the follicle, anastomosing with the first branch. The third passing superficially gives rise to capillaries encircling the hyaline membrane reaching up to the deeper part of the ringwulst, from which region some of the injection mass could usually be seen escaping into the upper part of the cavernous sinus. The injection mass never passed readily into the sinuses, which always contained blood even when an otherwise complete injection of the mystacial region had been accomplished.

The efferent drainage of the follicle, the existence of which has not previously been reported, consists of a number of fine vessels (diameter c. 4 μ) arising adjacent to the hyaline membrane and joining to form three principal vessels also of capillary dimensions (Fig. 2). These unite and pass through the outer

(1) Artery supplying muscle, on left, before traversing outer dermal sheath into follicle; ringwulst and ring sinus above; main vein of region running deep, below. Forward injection. Rat, × 30

(2) Part of follicle showing fine efferent vessels. Retrograde injection using 'Priscol'. Rat, × 65

(3) Longitudinal section of base of follicle; afferent vessel to ascending papillary plexus on left; large efferent vessel on right. Forward injection. Frozen section. Cat, × 30

dermal sheath in the deeper third of the follicle. Immediately outside the sheath the efferent vessel enlarges (*c.* 11 μ) and joins a vein into which the efferent vessel of the dermal papilla also drains.

The afferent vessel of the papilla derived from the arterial branch to the hair matrix is minute (*c.* 5 μ), and gives rise to a network of capillaries covering the surface of the papilla, ascending to its apex in long twisting loops similar to those seen in dermal papillæ in other situations (Fig. 3). The capillaries drain into a central efferent vessel of larger calibre (*c.* 20 μ) which leaves the base of the follicle.

The vascular pattern of the papilla is related, no doubt, to the high metabolic demand of an actively growing region. In marked contrast, the relative dimensions of the afferent and efferent vessels to the sinus system suggest that blood is held in the sinuses under considerable pressure, providing a medium in which the hair and its root sheaths are suspended in a cradle of elastic strands, the trabeculæ. This view is supported by experimental evidence which will be published at a later date.

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[1] Ryder, M. L., *Nature*, **172**, 125 (1953).
[2] Ryder, M. L., and Auber, L., *Nature*, **174**, 743 (1954).

Adult Behaviour-Pattern of *Anopheles gambiae* in Mauritius

Senior-White[1] has suggested a most convenient system of classification for the adult behaviour of anopheline mosquitoes, especially the vectors of malaria. The classification is of considerable importance when assessing the vectorial capacity of *Anopheles gambiae*, which ought now to be regarded as a mosquito the behaviour of which is considerably plastic; it certainly is not "a vector wherever found". Under the environmental conditions of an oceanic island, such as Mauritius, *A. gambiae* appears to lose its addiction for man. It may be that when it first made its appearance in the island in the 1860's its full genetical complex was missing. Again, there is a suggestion of a behaviour cline, *A. gambiae* becoming less and less closely associated with man as its distribution recedes from the equatorial regions.

Studies made since 1952 have shown that *A. gambiae* in Mauritius is strongly endophilic. Only the unfed and unfertilized females are to be found resting out of doors. Male *A. gambiae* are, however, strongly exophilic, and may be readily collected from rock crevices. Although it is so strongly endophilic, this is for cowsheds only. It is most unusual to find resting individuals in houses. Gebert[2] collected 46 from 12,561 houses, and Halcrow[3] found 6 unfed *A. gambiae* in 704 houses. Precipitin tests have shown that the small number of the species that do feed on humans rest immediately afterwards in cowsheds. It is suggested that Senior-White's classification of 'endophilic' should be subdivided into endophilic (houses) and endophilic (animal shelters); thus allowing for the unusual behaviour of the Mauritian *A. gambiae*.

Precipitin tests, based on 1,252 stomach smears of blood-fed *A. gambiae*, show a zoophilic index of more than 70 per cent, and an anthropophilic index of 2·8 per cent. Since 1,240 of the 1,252 smears were collected in cowsheds and from areas where herd cattle were absent and where the cattle were stalled in the cowsheds throughout the day and night, it would seem that a considerable degree of endophagy would be indicated. Very few of the smears were negative for both cattle and man. As it is impossible to say whether the low number of blood-fed *A. gambiae* proved positive for humans obtained their blood meal in houses or in the open (the latter being more probable), a small degree of exophagism could be accorded to the species.

The deviation of *A. gambiae* into cowsheds might be explained by the great number of cowsheds in Mauritius. One-third of all buildings in Mauritius are cowsheds; in several villages within areas of prolific breeding of *A. gambiae* the cowshed-to-house ratio is 1 : 1.

From observations made since 1952, it would seem that *A. gambiae* in Mauritius was, and is, a poor vector of malaria and bancroftian filariasis. It is thought that the presence of *Anopheles funestus*, now eradicated, enhanced the low vectorial capacity of *A. gambiae* by building up malaria to almost epidemic proportions. In such an event *A. gambiae* would be more likely to become infected than at the present time, when the very low endemic malaria is dissipated by the deviation of this species to cattle.

A summary of the adult behaviour pattern of *A. gambiae*, as it is found in Mauritius, is as follows: almost completely endophilic (animal shelters); strongly endophagic and weakly exophagic. This summary could be combined with other behaviour-pattern summaries from other geographical regions, and could form the basis for a study of a possible 'behaviour-cline' in *A. gambiae*.

Acknowledgment is made to the Colonial Insecticides Committee, which has financed this study.

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[1] Senior-White, R., *Nature*, **173**, 730 (1954).
[2] Gebert, S., Report of Medical Dept., Mauritius (1952).
[3] Halcrow J. G. (unpublished report, 1953).

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, February 28

UNIVERSITY OF LONDON (in the Physiology Theatre, University College, Gower Street, London, W.C.1), at 4.45 p.m.—Dr. Joseph Needham, F.R.S.: "New Light on the Physico-Chemical Aspects of Morphogenesis".* (Further lectures on March 7 and 14.)

UNIVERSITY OF LONDON (at King's College, Strand, London, W.C.2), at 5.30 p.m.—Mrs. Jean Floud: "Education and Social Class in the Welfare State".* (Last of a series of lectures on "Looking Forward in Education".)

INSTITUTION OF THE RUBBER INDUSTRY (at the Engineers' Club, Albert Square, Manchester), at 6.45 p.m.—Prof. G. Gee, F.R.S.: "Limitations of Rubbers".

Tuesday, March 1

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 1.15 p.m.—Prof. S. E. Hollingworth: "Geological Expedition to Northern Norway".*

INSTITUTION OF CIVIL ENGINEERS (at Great George Street, Westminster, London, S.W.1), at 5.30 p.m.—Mr. J. P. Stott: "Prestressed Concrete Roads".

INSTITUTION OF ELECTRICAL ENGINEERS, MEASUREMENTS SECTION (at Savoy Place, London, W.C.2), at 5.30 p.m.—Prof. F. Brailsford and Mr. C. G. Bradshaw: "Iron Losses at High Magnetic Flux Densities in Electrical Sheet Metals"; Dr. C. D. Mee and Dr. R. Street: "An Improved Precision Permeameter".

UNIVERSITY OF LONDON, BRITISH POSTGRADUATE MEDICAL FEDERATION (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.30 p.m.—Dr. C. H. Andrewes, F.R.S.: "The New Look in Virus Research". (Last of a series of lectures on "The Scientific Basis of Medicine".)*

UNIVERSITY OF LONDON (at King's College, Strand, London, W.C.2), at 5.30 p.m.—Prof. Cyril Domb: "Statistical Physics and its Problems".*

SOCIETY OF CHEMICAL INDUSTRY, PLASTICS AND POLYMER GROUP (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Dr. P. Hermans: "The Chemistry of the Polymerization of Caprolactam".

ROYAL AERONAUTICAL SOCIETY (at 4 Hamilton Place, London, W.1), at 7 p.m.—Prof. J. V. Connolly: "The Scientific Approach and Research in Aircraft Production".

Wednesday, March 2

ROYAL SOCIETY OF MEDICINE, HISTORY OF MEDICINE SECTION (at 1 Wimpole Street, London, W.1), at 5.15 p.m.—Dr. Ff. Roberts: "The Effects of Epidemics on Population and Social Life".

INSTITUTION OF ELECTRICAL ENGINEERS, RADIO SECTION (at Savoy Place, London, W.C.2), at 5.30 p.m.—Scientific Papers.

Thursday, March 3

UNIVERSITY OF LONDON (at the Royal Veterinary College, Royal College Street, London, N.W.1), at 4 p.m.—Prof. Nils Lagerlöf (Stockholm): "Some Infertility Factors in Domestic Animals".* (Further lecture on March 4.)

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Mr. G. Badami and Sir Alfred Egerton, F.R.S.: "The Determination of Burning Velocities of Slow Flames"; Prof. R. G. W. Norrish, F.R.S., Mr. G. Porter and Mr. B. A. Thrush: "Studies of the Explosive Combustion of Hydrocarbons by Kinetic Spectroscopy".

LINNEAN SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Dr. T. B. Reynoldson: "Current Taxonomy of the Freshwater Triclads of the British Isles"; Dr. G. S. Carter: "The Papyrus Swamps of Uganda: the Nature of the Environment".

ROYAL SOCIETY OF ARTS, COMMONWEALTH SECTION (at John Adam Street, Adelphi, London, W.C.2), at 5.15 p.m.—Prof. Max Gluckman: "Anthropology in Central Africa".

UNIVERSITY OF LONDON (at King's College, Strand, London, W.C.2), at 5.30 p.m.—Prof. R. M. Titmuss: "War and Social Policy".* (From a series of lectures on "War and Society".)

INSTITUTE OF METALS, LONDON LOCAL SECTION (at 4 Grosvenor Gardens, London, S.W.1), at 6.30 p.m.—Dr. T. G. Pearson: "Physical and Chemical Processes Occurring in the Electrolytic Production of Aluminium".

UNIVERSITY OF LONDON (at Wye College, Wye, near Ashford, Kent), at 8.15 p.m.—Dr. H. J. Frankena (Wageningen): "Full Utilization of Pasture".*

Friday, March 4

SOCIETY FOR ANALYTICAL CHEMISTRY (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 2.45 p.m.—Annual General Meeting. Dr. D. W. Kent-Jones—Address of the Retiring President.

PHYSICAL SOCIETY, ACOUSTICS GROUP (in the Physics Department of Imperial College, Imperial Institute Road, London, S.W.7), at 5.30 p.m.—Dr. H. Mol: "Identification of Speech Sounds".

BRITISH SOCIETY FOR THE HISTORY OF SCIENCE, PHILOSOPHY OF SCIENCE GROUP—NORTHERN BRANCH (in the Medical Library, The University, Sheffield), at 7.30 p.m.—Sir Ernest Finch: "Leonardo da Vinci".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Sir Frederic Bartlett, F.R.S.: "Thinking—an Experimental Approach".

Saturday, March 5

LONDON COUNTY COUNCIL (at the Horniman Museum, London Road, Forest Hill, London, S.E.23), at 3.30 p.m.—Dr. Glyn E. Daniel: "The Megalith Builders".*

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

SENIOR LECTURER (with high academic and research qualifications, and able to teach to special (honours) degree standard) IN ORGANIC CHEMISTRY—The Clerk to the Governors, Woolwich Polytechnic, London, S.E.18 (March 4).

LECTURER IN PHYSICAL CHEMISTRY at Wolverhampton and Staffordshire Technical College—The Clerk to the Joint Education Committee, Education Offices, North Street, Wolverhampton (March 5).

NON-MEDICAL BIOCHEMIST (Senior Grade)—The Secretary, General Hospital, Nottingham (March 5).

SENIOR LECTURER IN PHYSICS, a LECTURER IN PHYSICS, LECTURERS (3) IN MATHEMATICS, LECTURERS (2) IN GENERAL SCIENCE, and a LECTURER IN CHEMISTRY, at Kumasi College of Technology, Gold Coast—The Secretary, Advisory Committee on Colonial Colleges, 1 Gordon Square, London, W.C.1 (March 7).

CHEMICAL ENGINEER (with a first- or second-class honours degree or equivalent qualification in chemical engineering) at a Ministry of Supply Establishment in S.W. England, for work which is concerned with the development of chemical processes involving semi-technical research, design and operation of pilot units and basic research in chemical engineering operations—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting F.60/5A (March 12).

PROFESSOR (able to pass an examination in Irish) OF MATHEMATICS—The Secretary, University College, Cork, Ireland (March 14).

ASSISTANT LECTURER (preferably with special qualifications in algebra and/or geometry) IN MATHEMATICS—The Secretary, Westfield College (University of London), Hampstead, London, N.W.3 (March 15).

ASSISTANT LECTURER IN THEORETICAL PHYSICS—The Registrar, The University, Manchester 13 (March 16).

ASSISTANTS IN RESEARCH (3) (with an honours degree in an appropriate subject) in agricultural engineering, animal physiology and soil science—The Secretary, School of Agriculture, Downing Street, Cambridge (March 16).

SCIENTIFIC OFFICER (with a good honours degree in science) IN THE FORAGE CROPS SECTION, to engage in genetical, physiological and breeding research in grasses and legumes—The Secretary, Plant Breeding Institute, Trumpington, Cambridge (March 16).

LECTURER IN VERTEBRATE ZOOLOGY—The Registrar, King's College, Strand, London, W.C.2 (March 18).

SENIOR RESEARCH OFFICER or RESEARCH OFFICER (physicist or engineer) (with an honours degree in science or engineering, and preferably with industrial research experience) IN THE WOOL TEXTILE RESEARCH LABORATORIES, Geelong, Victoria, Australia, to carry out developmental work on wool textile machinery—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2 (March 19).

MONSANTO RESEARCH SCHOLAR (with a degree in science or engineering) IN CHEMICAL ENGINEERING—The Registrar, New South Wales University of Technology, Broadway, Sydney, N.S.W., Australia (March 21).

RESEARCH FELLOW IN ELECTRON PHYSICS—The Registrar, The University, Edgbaston, Birmingham (March 26).

LECTURER IN APPLIED MATHEMATICS at St. Salvator's College, St. Andrews—Joint Clerk to the University Court, The University, St. Andrews (March 31).

LECTURER IN APPLIED MATHEMATICS—The Secretary and Registrar, The University, Southampton (March 31).

PROFESSOR (with a higher degree and teaching experience at university level, and with substantial research experience in the field of mathematics) OF MATHEMATICS, at the University of Queensland, Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (March 31).

CHAIR OF APPLIED MATHEMATICS—The Registrar, The University, Sheffield 10 (April 2).

SENIOR LECTURER IN LAND SURVEYING at the University of Cape Town, South Africa—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Cape Town, April 15).

CHAIR OF SURGERY in the University of Cape Town—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Cape Town, April 30).

ASSISTANT CONSERVATOR (with a degree in forestry, and preferably under 40 years of age) OF FORESTS, Cyprus—The Director of Recruitment, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting BCD.61/17/01.

ASSISTANT LECTURER IN GEOLOGY—The Registrar, The University, Nottingham.

BIOCHEMIST (non-medical, senior grade, and preferably with research experience) IN THE PATHOLOGICAL DEPARTMENT, for duties which consist of routine and more advanced biochemical techniques—The Consultant Pathologist, Hill End Hospital, St. Albans, Herts.

BRADFORD DYERS' ASSOCIATION LIMITED RESEARCH FELLOW (with high qualifications in science), to undertake research in tinctorial chemistry, textile chemistry or an allied subject—The Principal, Technical College, Bradford.

ENTOMOLOGIST (preferably with postgraduate experience) IN THE RESEARCH SECTION of the Agricultural Department, Aden, to work on cotton and other crops—The Secretary, Empire Cotton Growing Corporation, 12 Chantrey House, Eccleston Street, London, S.W.1.

EXPERIMENTAL OFFICER (male) (with a degree or diploma in agriculture), AT THE SCOTTISH PLANT BREEDING STATION, to take charge of the organization and conduct of field work connected with the Station's scientific programme; and an ASSISTANT EXPERIMENTAL OFFICER (male) (with a degree or diploma in agriculture or botany) to assist in the Cereals Research Section—The Secretary, Scottish Plant Breeding Station, Pentlandfield, Roslin, Midlothian.

EXPERIMENTAL OFFICERS (preferably with a pass degree), and ASSISTANT EXPERIMENTAL OFFICERS (with at least H.S.C.), with the United Kingdom Atomic Energy Authority, Foulness, Essex, to assist in the development of electronic instruments to record air shock—Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berks, quoting 215.A/WCE/2.

FIELD GEOLOGISTS (with a first- or good second-class honours degree in geology) in the Geological Survey Departments of the following territories: East Africa—Kenya and Tanganyika; Central Africa—Nyasaland, Northern Rhodesia; West Africa—Federation of Nigeria, Sierra Leone; South-East Asia—Federation of Malaya; Other Territories—Somaliland Protectorate, Bechuanaland, British Guiana—The Director of Recruitment, Colonial Office, Overseas Service Division, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting BCD.104/04.

LABORATORY TECHNICIAN (with experience in organic-chemistry research work) IN THE MICROBIOLOGY SECTION, for work on plant constituents—The Secretary, Department of Forestry, Imperial Forestry Institute, University of Oxford.

LECTURER IN ASTRONOMY, and LECTURERS (2) IN RADIO ASTRONOMY—The Registrar, The University, Manchester 13.

LECTURER (with a degree or diploma in agriculture and experience of teaching or lecturing) IN AGRICULTURE, at the Natural Resources School, Tengeru, Tanganyika—The Director of Recruitment, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting BCD/63/8/06.

LECTURER (with special interests in either hydro- or aero-dynamics, or in electromagnetic theory) IN MATHEMATICS—Head of the Department of Mathematics, Imperial College, London, S.W.7.

MASTER to teach CHEMISTRY to scholarship level—Downside School, Stratton-on-the-Fosse, Bath, Somerset.

ORGANIC MICRO ANALYST (Senior Technician grade) IN THE DEPARTMENT OF CHEMISTRY—The Chief Technician, Department of Chemistry, The University, Oxford Road, Manchester 13.

PHYSICIST (with a good honours degree) to assist in research into the fundamental principles underlying the processing of textile fibres into yarns—The Secretary, British Jute Trade Research Association, Kinnoull Road, Kingsway West, Dundee.

PLANT PHYSIOLOGIST (with, or expect to be awarded this year, a degree in natural science and training in plant physiology), at the Coffee Research Station, Ruiru, Kenya, to investigate diseases of the coffee berry—The Director of Recruitment, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting BCD.63/7/015.

READER and SENIOR LECTURERS or LECTURERS IN PHYSICS—The Dean, College of Arts and Science, Baghdad, Iraq.

RESEARCH ASSISTANT (with qualifications in mathematics, physics or chemistry) IN THE DEPARTMENT OF INORGANIC AND STRUCTURAL CHEMISTRY—Prof. E. G. Cox, Department of Inorganic or Structural Chemistry, The University, Leeds 2.

RESEARCH FELLOW IN THE DEPARTMENT OF CHEMISTRY, for work on the mechanisms of changes produced in polymers by radiations—The Registrar, The University, Edgbaston, Birmingham 15.

SCIENTIFIC ASSISTANT FOR GREENHOUSE EXPERIMENTS, to take charge of the experimental work with sand and water cultures in connexion with investigations on the mineral nutrition of fruit crops—The Secretary, University of Bristol, Department of Agriculture and Horticulture, Research Station, Long Ashton, Bristol.

SCIENTIFIC OFFICER or SENIOR SCIENTIFIC OFFICER (with a first-class honours degree in a natural science, and at least two years post-graduate research experience, preferably of freshwater fish and fisheries) at the Jinja (Uganda) Laboratories of the East African Fisheries Research Organization, to carry out research into the ecology and/or physiology of fish—The Director of Recruitment, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting BCD.195/194/02.

TECHNICIAN IN THE DEPARTMENT OF CHEMICAL ENGINEERING, to assist in the preparation of Co-enzyme "A"—The Secretary, University College, Gower Street, London, W.C.1, quoting "Chem. Eng./3".

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Industrial Management: a Course of Lectures given at Cambridge University for the Faculty Board of Engineering, 1953. Pp. 124. (Sheffield: United Steel Companies, Ltd., 1954.) [1512

Aero Research Technical Notes. Bulletin No. 143 (November 1954): Synthetic Resin Glues in the Building Industry. Part 2: Some Further Notes on "Aerolite" 300 for Timber Roof Trusses. Pp. 5. (Duxford: Aero Research Limited, 1954.) [1512

Overseas Food Corporation. Annual Report and Statement of Accounts for the year ended 31st March, 1954. Pp. iv+70. (London: H.M. Stationery Office, 1954.) 2*s*. 6*d*. net. [1512

Air Ministry. Meteorological Office. Instructions for the Preparation of Weather Maps, with Tables of the Specifications and Symbols. Second edition. Pp. ii+49. (M.O. 515.) (London: H.M. Stationery Office, 1954.) 1*s*. 9*d*. net. [1512

Philosophical Transactions of the Royal Society of London. Series B: Biological Sciences. No. 653, Vol. 238 (10 December 1954): *Elephantulus* Going Into Anoestrus: Menstruation and Abortion. By C. J. van der Horst. The Lactation Cycle of *Elephantulus Myurus Jamesoni* (Chubb). By Muriel J. McKerrow. The Male Genital System and Reproductive Cycle of *Elephantulus Myurus Jamesoni* (Chubb). By Zelda G. Stoch. Pp. 27–126+2 plates. (London: Royal Society, 1954.) 35*s*. [1512

Department of Scientific and Industrial Research. Chemical Research Laboratory. The National Collection of Industrial Bacteria—Catalogue of Strains maintained at the Chemical Research Laboratory, Teddington, Middlesex. Pp. ii+32. (London: H.M. Stationery Office, 1954.) 2*s*. net. [1712

Customs and Excise. Tables showing the relation between the Specific Gravity of Spirits at $\frac{20°}{20°}$ Centigrade and the Percentage of Ethyl Alcohol by Weight and by Volume, with corresponding percentage of proof spirit. Pp. iv+35. (London: H.M. Stationery Office, 1954.) 4*s*. net. [1712

Southern Regional Council for Further Education. Seventh Annual Report, October 1954. Pp. 30. (Reading: Southern Regional Council for Further Education.) [1712

Other Countries

Bulletin of the Central Leather Research Institute, Madras. Vol. 1, No. 1 (August, 1954). Pp. ii+26. (Issued monthly.) Annual subscription 9 rupees (inland); 18 rupees (foreign); single issues 12 annas. (Madras: Central Leather Research Institute, 1954.) [912

Canada: Department of Mines and Technical Surveys. Geological Survey of Canada. Memoir No. 272: Geology and Mineral Deposits of the Zeballos-Nimpkish Area, Vancouver Island, British Columbia. By J. W. Hoadley. Pp. vii+82 (5 plates). 1 dollar. Memoir 273: The Lower Mackenzie River Area, Northwest Territories and Yukon. By G. S. Hume. Pp. viii+118 (3 plates). 1 dollar. Memoir 276: La Poile-Cinq Cerf Map-Area, Newfoundland. By J. R. Cooper. Pp. vii+62 (4 plates). 75 cents. Bulletin 27: Contributions to the Economic Geology of Western Newfoundland. The Strontium Deposits of Port Au Port Peninsula. By Helgi Johnson. The Magnetite and Gypsum Deposits of the Sheep Brook-Lookout Brook Area. By David M. Baird. The Iron Deposits of Indian Head Area. By Allen V. Heyl and John J. Roman. Pp. vii+65 (4 plates). 50 cents. Annual Report 1953, fiscal year ended March 31. Pp. 98. 50 cents. (Ottawa: Queen's Printer, 1954). [912

Indian Forest Bulletin No. 180 (New Series): Cellulose and Paper—Indigenous Cellulosic Raw Materials for the Production of Pulp, Paper and Board. Part 18: Chemical Pulps for Writing and Printing Papers from *Sterculia alata* Roxb. (*Ietkot*). By R. V. Bhat and P. R. Gupta. Pp. ii+5. (Delhi: Manager of Publications, 1954.) 6 annas; 7*d*. [912

Indian Forest Records (New Series). Silviculture. Vol. 9, No. 2: Phenological Behaviour of a Few Forest Species at New Forest, Dehra Dun. By V. S. Krishnaswamy and G. S. Mathauda. Pp. ii+89–134. (Delhi: Manager of Publications, 1954.) 2 rupees, 8 annas; 4*s*. [912

Landwirtschaft—Angewandte Wissenschaft. Lokalklimatische Untersuchungen im Raum der Harburger Berge und der benachbaeten Elbniederung. Von Dr. Josef van Eimern und Dipl. Met. Egon Kaps. Pp. 112. Ergebnisse von Windschutzuntersuchungen in Hamburg-Garstedt, 1952. Von Dr. Josef van Eimern, Ernst Kranken und Dipl. Met. Heinz Harries. Pp. 96. (Herausgegeben vom Bundesministerium für Ernährung, Landwirtschaft und Forsten.) (Hiltrup bei Munster (Westf.): Landwirtschaftsverlag, G.m.b.H., 1954.) [1412

Berichte der Naturforschenden Gesellschaft zu Freiburg i. Br. 44 Band: Freiburg und der Breisgau: Ein Führer durch Landschaft und Kultur. Von Nikolaus Creutzburg, Heinz Eggers, Werner Noack und Max Pfannenstiel. Pp. 312. (Freiburg im Breisgau: Verlag Hans Ferdinand Schulz, 1944.) 16 D. marks. [1412

Norsk Polarinstitutt. Meddelelser Nr. 78: Landmåleriv i Dronning Maud Land. Av Nils Roer. Pp. 245–266. 2 kronor. Meddelelser Nr. 79: Pollen og sporer i tertiaere kull fra Vestspitsbergen. Av Svein Manum. Pp. 10+2 plates. 2 kronor. Skrifter Nr. 99: Eskimo Metabolism: a Study of Racial Factors in Basal Metabolism. By Kåre Rodahl. Pp. 83. 10 kronor. Skrifter Nr. 100: Notes on Some Corals from Late Paleozoic Rocks of Inner Isfjorden, Spitsbergen. By Peter Padget. Pp. 10. 1 kronor. Skrifter Nr. 101: Svalbard in International Politics, 1871–1925—The Solution of a Unique International Problem. By Trygve Mathisen. Pp. 211. 18 kronor. Skrifter Nr. 102: Studies on the Blood and Blood Pressure in the Eskimo and the Significance of Ketosis Under Arctic Conditions. Av K. Rodahl. Pp. 79. 10 kronor. (Oslo: Broggers Boktrykkeris Forlag, 1954.) [1412

Queensland. Institute of Medical Research. Ninth Annual Report, year ended 30th June, 1954. Pp. 13. (Brisbane: Government Printer, 1954.) [1512

Commonwealth of Australia—Department of External Affairs. Australian National Antarctic Research Expeditions. Interim Reports 1: Seal Marking at Heard Island, 1949. By R. G. Chittleborough and E. M. M. Ealey. Pp. ii+23+6 plates. (Melbourne: Department of External Affairs (Antarctic Division), 1951.) [1512

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MACMILLAN & CO., LTD.,
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Telephone Number: Whitehall 8831. Telegrams: Phusis Lesquare London

Annual subscription £6, payable in advance, postage paid to any part of the world

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